YAMAHA
YAMAHA MOTOR CO., LTD.

YAMAHA SCARA ROBOT YK-X series

YK-XG

User's Manual

ENGLISH E

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Before using the robot
(Be sure to read the following notes.)

At this time, our thanks for your purchase of this YAMAHA YK-XG series SCARA robot.

1. Please be sure to perform the following tasks before using the robot.

Failing to perform the tasks below will require re-teaching of the robot since the origin position cannot be set to the same previous position. Robot malfunctions (vibration, noise) may also occur.

The origin position of the YK-XG series robots is adjusted to the robot arm extended position at the factory prior to shipment, so the reference or standard coordinates are temporarily set. The customer should set the origin position before any other job. There are 2 types of origin position settings as shown below.

[1] Setting the robot arm extended position (the origin position adjusted at the factory prior to shipment) as the origin position
(When setting the origin position with the robot arm extended, you must check that there will not be any interference from any peripheral equipment during the next absolute reset.)

[2] Setting a position **OTHER** than the robot arm extended position (the origin position adjusted at the factory prior to shipment) as the origin position

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[1] To set the robot arm extended position (the origin position adjusted at the factory prior to shipment) as the origin position

Absolute Reset

The YK-XG series robots only require the absolute reset to be performed once when the robot is introduced. Once the absolute reset is performed, you do not need to reperform it when the power is turned on next time. Set the origin position while referring to absolute reset methods in "3. Adjusting the origin" in Chapter 4 of this manual and in "Absolute Reset" of the "YAMAHA Robot Controller User's Manual". Setting of standard coordinates is not required in the above case. To set the standard coordinates with high accuracy, refer to "5. Setting the Standard Coordinates" in Chapter 4 of this manual and "Setting the Standard Coordinates" in the "YAMAHA Robot Controller User's Manual". If the standard coordinate settings are incorrect, robot malfunctions (vibration, excessive noise) may occur.

⚠CAUTION

Never enter the robot movement range once the robot servo is turned on as this is extremely hazardous.

[2] To set a position **OTHER** than the robot arm extended position (the origin position adjusted at the factory prior to shipment) as the origin position

1. Absolute reset

The YK-XG series robots only require the absolute reset to be performed once when the robot is introduced. Once the absolute reset is performed, you do not need to reperform it when the power is turned on next time. Set the origin position while referring to absolute reset methods in "3. Adjusting the origin" in Chapter 4 of this manual and in "Absolute Reset" of the "YAMAHA Robot Controller User's Manual". Set the origin position with the absolute reset.

⚠CAUTION

Never enter the robot movement range once the robot servo is turned on as this is extremely hazardous.

2. Affixing the origin position sticker

Set in emergency stop when absolute reset is complete, and immediately affix the origin point sticker according to instructions in "6. Affixing Stickers for Origin Positions, Movement Directions and Axis Names" in Chapter 4 of this manual.

3. Setting the reference coordinates

Set the reference coordinates while referring to instructions in "5. Setting the Reference Coordinates" in Chapter 4 of this manual and also to "Setting the Reference Coordinates" in the "YAMAHA Robot Controller User's Manual". Robot malfunctions (vibration, noise) may occur if the reference coordinates are not set correctly.

Even though there is no problem with the robot, the following error messages are issued when the robot and controller are connected and power first turned on. (Actual error messages may differ according to how the robot and controller are connected.)

Error messages issued when robot & controller are connected (RCX240)

17.81 : D?.ABS.battery wire breakage
17.83 : D?.Backup position data error 1
17.85 : D?.Backup position data error 2
17.92 : D?.Resolver disconnected during power off
17.93 : D?.Position backup counter overflow
etc.

2. If the X, Y or R axis rotation angle is small.

If the X, Y or R axis rotation angle is smaller than 5° so that it always moves in the same position, an oil film is difficult to be formed on the joint support bearing, possibly leading to damage to the bearing. In this type of operation, add a movement so that the joint moves through 90° or more, about 5 times a day.

3. Do not remove the Z-axis upper-end mechanical stopper

Removing or moving the upper-end mechanical stopper attached to the Z-axis spline can damage the Z-axis ball screw. Never remove or move it.

Introduction

The YAMAHA YK-XG series robots are SCARA type industrial robots developed based on years of YAMAHA experience and achievements in the automation field as well as efforts to streamline our in-house manufacturing systems. The YK-XG series robots have a two-joint manipulator consisting of an X-axis arm and a Y-axis arm, and are further equipped with a vertical axis (Z-axis) and a rotating axis (R-axis) at the tip of the manipulator. The YK-XG series robots can be used for a wide range of assembly applications such as installation and insertion of various parts, application of sealant, and packing operations.

This instruction manual describes the safety measures, handling, adjustment and maintenance of YK-XG series robots for correct, safe and effective use. Be sure to read this manual carefully before installing the robot. Even after you have read this manual, keep it in a safe and convenient place for future reference. This instruction manual should be used with the robot and considered an integral part of it. When the robot is moved, transferred or sold, send this manual to the new user along with the robot. Be sure to explain to the new user the need to read through this manual.

This manual describes the YK500XG, YK600XG, YK600XGH, YK700XG, YK800XG, YK900XG, and YK1000XG. For details on specific operation and programming of the robot, refer to the separate "YAMAHA Robot Controller User's Manual".

NOTES

- The contents of this manual are subject to change without prior notice.
- Information furnished by YAMAHA in this manual is believed to be reliable. However, if you find any part unclear or inaccurate in this manual, please contact YAMAHA sales office or dealer.

YAMAHA MOTOR CO., LTD.
IM Operations

MEMO

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CHAPTER 1

Using the Robot Safely

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MEMO

1 Safety Information

Industrial robots are highly programmable, mechanical devices that provide a large degree of freedom when performing various manipulative tasks. To ensure correct and safe use of YAMAHA industrial robots, carefully read this manual and make yourself well acquainted with the contents. FOLLOW THE WARNINGS, CAUTIONS AND INSTRUCTIONS INCLUDED IN THIS MANUAL. Failure to take necessary safety measures or mishandling due to not following the instructions in this manual may result in trouble or damage to the robot and injury to personnel (robot operator or service personnel) including fatal accidents.

Warning information in this manual is shown classified into the following items.

⚠ DANGER

Failure to follow DANGER instructions will result in severe injury or death to the robot operator, a bystander or a person inspecting or repairing the robot.

⚠ WARNING

Failure to follow WARNING instructions could result in severe injury or death to the robot operator, a bystander or a person inspecting or repairing the robot.

⚠ CAUTION

Failure to follow CAUTION instructions may result in injury to the robot operator, a bystander or a person inspecting or repairing the robot, or damage to the robot and/or robot controller.

NOTE

Explains the key point in the operation in a simple and clear manner.

Refer to the instruction manual by any of the following methods to operate or adjust the robot safely and correctly.

1. Operate or adjust the robot while referring to the printed version of the instruction manual (available for an additional fee).
2. Operate or adjust the robot while viewing the CD-ROM version of the instruction manual on your computer screen.
3. Operate or adjust the robot while referring to a printout of the necessary pages from the CD-ROM version of the instruction manual.

It is not possible to detail all safety items within the limited space of this manual. So it is essential that the user have a full knowledge of basic safety rules and also that the operator makes correct judgments on safety procedures during operation. This manual and warning labels supplied with or affixed to the robot are written in English. If the robot operator or service personnel does not understand English, do not permit him to handle the robot.

2 Essential Caution Items

Particularly important cautions for handling or operating the robot are described below. In addition, safety information about installation, operation, inspection and maintenance is provided in each chapter. Be sure to comply with these instructions to ensure safe use of the robot.

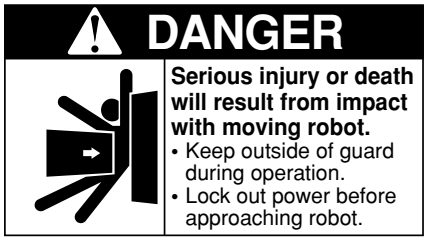
(1) Observe the following cautions during automatic operation.

Warning labels 1 (Fig. 1-1) are affixed to the robot. See Fig. 2-2 for the locations of warning labels.

- Install a safeguard enclosure (protective enclosure) to keep any person from entering within the movement range of the robot and suffering injury due to being struck by moving parts.
- Install a safety interlock that triggers emergency stop when the door or panel is opened.
- Install safeguards so that no one can enter inside except from doors or panels equipped with safety interlocks.
- The warning labels shown in Fig. 1-1 are supplied with the robot and should be affixed to a conspicuous spot on doors or panels equipped with safety interlocks.

⚠ DANGER

Serious injury or death will result from impact with moving robot.
• Keep outside of guard during operation.
• Lock out power before approaching robot.


DANGER
Serious injury or death will result from impact with moving robot.
• Keep outside of guard during operation.
• Lock out power before approaching robot.

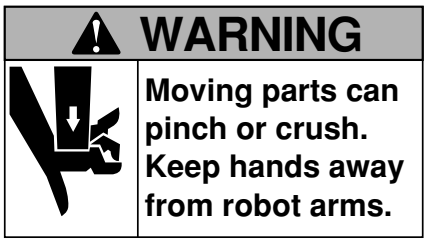
■Fig. 1-1 Warning label 1

(2) Use caution to prevent hands or fingers from being pinched or crushed.

Warning labels 2 (Fig. 1-2) are affixed to the robot. See Fig. 2-2 for the locations of warning labels. Be careful not to let hands or fingers be pinched or crushed by the moving parts of the robot during transportation or teaching.

⚠ WARNING

Moving parts can pinch or crush hands. Keep hands away from robot arms.



■Fig. 1-2 Warning label 2

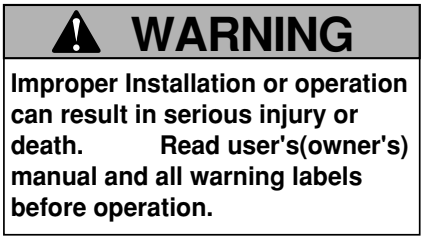
(3) Follow the instructions on warning labels and in this manual.

Warning label 3 (Fig. 1-3) is affixed to the robot. See Fig. 2-2 for the locations of warning labels.

- Be sure to read the warning label and this manual carefully and make you thoroughly understand the contents before attempting installation and operation of the robot.
- Before starting the robot operation, even after you have read through this manual, read again the corresponding procedures and cautions in this manual as well as descriptions in this chapter (Chapter 1, "Using the Robot Safely").
- Never install, adjust, inspect or service the robot in any manner that does not comply with the instructions in this manual.

⚠WARNING

Improper installation or operation can result in serious injury or death.
Read user's manual and all warning labels before installation or operation.


WARNING
Improper Installation or operation can result in serious injury or death. Read user's(owner's) manual and all warning labels before operation.

■Fig. 1-3 Warning label 3

(4) Do not remove the Z-axis upper-end mechanical stopper

Removing or moving the upper-end mechanical stopper attached to the Z-axis spline can damage the Z-axis ball screw. Never remove or move it.

⚠CAUTION

Do not remove this part. Damage to the ball screw will result.

■Fig. 1-4 Warning label 4

(5) Do not use the robot in environments containing inflammable gas, etc.

⚠ WARNING

- This robot was not designed for operation in environments where inflammable or explosive substances are present.
- Do not use the robot in environments containing inflammable gas, dust or liquids. Explosions or fire could otherwise result.

(6) Do not use the robot in locations possibly subject to electromagnetic interference, etc.

⚠ WARNING

Avoid using the robot in locations subject to electromagnetic interference, electrostatic discharge or radio frequency interference. Malfunction may otherwise occur.

(7) Use caution when releasing the Z-axis (vertical axis) brake.

⚠ WARNING

The Z-axis will slide down when the Z-axis brake is released, causing a hazardous situation.

- Press the emergency stop button and prop up the Z-axis with a support stand before releasing the brake.
- Use caution not to let your body get caught between the Z-axis and installation base when releasing the brake to perform direct teach.

(8) Provide safety measures for end effector (gripper, etc.).

⚠ WARNING

- End effectors must be designed and manufactured so that they cause no hazards (for example, loosening of workpiece) even if power (electricity, air pressure, etc.) is shut off or power fluctuations occur.
- If there is a possible danger that the object gripped by the end effector may fly off or drop, then provide appropriate safety protection taking into account the object size, weight, temperature and chemical properties.

(9) Be cautious of possible Z-axis movement when the controller is turned off or emergency stop is triggered. (2-axis robots with air-driven Z-axis)

⚠ WARNING

The Z-axis moves up when the power to the controller or PLC is turned off, the program is reset, emergency stop is triggered, or air is supplied to the solenoid valve for the Z-axis air cylinder.

- Do not let hands or fingers get caught and squeezed by moving parts of the Z-axis.
- Keep the usual robot position in mind so that the Z-axis will not interfere with obstacles during raising of the Z-axis, except in case of emergency stop.

(10) Use the following caution items when the Z-axis is interfering with peripheral equipment. (2-axis robots with air driven Z-axis)

⚠ WARNING

When the Z-axis comes to a stop due to obstructions from peripheral equipment, the Z-axis may move suddenly when the obstruction is removed, causing injury such as pinched or crushed hands.

- Turn off the controller and reduce the air pressure before attempting to remove the obstruction.
- Before reducing the air pressure, place a support stand under the Z-axis because it will drop under its own weight.

(11) Use caution on Z-axis movement when air supply is stopped. (2-axis robots with air-driven Z-axis)

⚠ WARNING

The Z-axis may suddenly drop when the air pressure to the Z-axis air cylinder solenoid valve is reduced, creating a hazardous situation.
Turn off the controller and place a prop or support under the Z-axis before cutting off the air supply.

(12) Use the following caution items when disassembling or replacing the pneumatic equipment.

⚠ WARNING

Air or parts may fly outwards if pneumatic equipment is disassembled or parts replaced while air is still supplied.

- Do service work after first turning off the controller and reducing the air pressure.
- Before reducing the air pressure, place a support stand under the Z-axis (2-axis robots with air driven Z-axis) since it will drop under its own weight.

(13) Use the following caution items when removing the Z-axis motor.

⚠ WARNING

The Z-axis will drop when the Z-axis motor is removed, possibly resulting in injury.

- Turn off the controller and set a support stand under the Z-axis before removing the motor.
- Use caution not to allow hands or body to be squeezed or crushed by moving parts on the Z-axis or between the Z-axis and the installation base.

(14) Use the following caution during inspection of controller.

⚠ WARNING

- When you need to touch the terminals or connectors on the outside of the controller during inspection, always first turn off the controller power switch and also the power source in order to prevent possible electrical shock.
- Never touch any internal parts of the controller.

For precautions on handling the controller, refer to the "YAMAHA Robot Controller User's Manual".

(15) Consult us for corrective action when the robot is damaged or malfunction occurs.

⚠ WARNING

If any part of the robot is damaged or any malfunction occurs, continuous operation may be very dangerous. Please consult YAMAHA dealer for corrective action.

If the following damages or troubles exist	These dangers can happen
Damage to machine harness or robot cable	Electrical shock, malfunction of robot
Damage to exterior of robot	Flying outwards of damaged parts during robot operation
Abnormal operation of robot (positioning error, excessive vibration, etc.)	Malfunction of robot
Z-axis brake trouble	Dropping of load

(16) Use caution not to touch the high temperature motor or speed reduction gear casing.

⚠ WARNING

The motor and speed reduction gear casing are extremely hot after automatic operation, so burns may occur if these are touched. Before touching these parts during inspections or servicing, turn off the controller, wait for a while and check that the temperature has cooled.

(17) Do not remove, alter or stain the warning labels.

⚠WARNING

If warning labels are removed or difficult to see, necessary cautions may not be taken, resulting in an accident.

- Do not remove, alter or stain the warning labels on the robot.
- Do not allow the warning labels to be hidden by the device installed to the robot by the user.
- Provide proper lighting so that the symbols and instructions on the warning labels can be clearly seen even from the outside of safeguard enclosure.

(18) Protective bonding

⚠WARNING

Be sure to ground the robot and controller to prevent electrical shock.

(19) Be sure to make correct parameter settings.

⚠CAUTION

The robot must be operated with correct tolerable moment of inertia and acceleration coefficients according to the manipulator tip mass and moment of inertia. If this is not observed, premature end to the life of the drive units, damage to the robot parts or residual vibration during positioning may result.

(20) Do not use the robot for tasks requiring motor thrust.

⚠CAUTION

Avoid using the YK-XG series robots for tasks which make use of motor thrust (press-fitting, burr removal, etc.). These tasks may cause malfunctions of the robot.

(21) If the X, Y or R axis rotation angle is small

⚠CAUTION

If the X, Y or R axis rotation angle is smaller than 5° so that it always moves in the same position, an oil film is difficult to be formed on the joint support bearing, possibly leading to damage to the bearing. In this type of operation, add a movement so that the joint moves through 90° or more, about 5 times a day.

3 Special Training for Industrial Robot Operation

Companies or factories using industrial robots must make sure that every person, who handles the robot such as for teaching, programming, movement check, inspection, adjustment and repair, has received appropriate training and also has the skills needed to perform the job correctly and safely.
Since the YK-XG series robots fall under the industrial robot category, the user must observe local regulations and safety standards for industrial robots, and provide special training for every person involved in robot-related tasks (teaching, programming, movement check, inspection, adjustment, repair, etc.).

4 Robot Safety Functions

(1) Overload detection

This function detects an overload applied to the motor and shuts off the servo power. If an overload error occurs, take the following measures.
1. Insert a timer in the program.
2. Reduce the acceleration coefficient.

(2) Overheat detection

This function detects an abnormal temperature rise in the driver inside the controller and shuts off the servo power. If an overheat error occurs, take the following measures.
1. Insert a timer in the program.
2. Reduce the acceleration coefficient.

(3) Soft limits

Soft limits can be set on each axis to limit the working envelope in manual operation after return-to-origin and during automatic operation.
Note: The working envelope is the area limited by soft limits.

(4) Mechanical stoppers

If the servo power is suddenly shut off during high-speed operation by emergency stop or safety functions, these mechanical stoppers prevent the axis from exceeding the movement range. The movement range is the area limited by mechanical stoppers.
- The movement ranges of the X-axis arm can be limited as needed by use of mechanical stoppers.
- On the Y-axis arm, mechanical stoppers are fixed at both ends of the maximum movement range.
- The Z-axis has a mechanical stopper at the upper end and lower end.
- No mechanical stopper is provided on the R-axis.

⚠ WARNING

Axis movement will not stop immediately after the servo power supply is shut off by emergency stop or other safety functions.

(5) Z-axis (vertical axis) brake

An electromagnetic brake is installed on the Z-axis to prevent the Z-axis from sliding down when servo power is turned off. This brake is working when the controller is off or the Z-axis servo power is off even when the controller is on. The Z-axis brake can be released by means of the programming unit or by a command in the program when the controller is on.

⚠ WARNING

The Z-axis will slide down when the Z-axis brake is released, creating a hazardous situation.
- Press the emergency stop button and prop the Z-axis with a support stand before releasing the brake.
- Use caution not to let your body get caught between the Z-axis and installation base when releasing the brake to perform direct teach.

5 Safety Measures for the System

Since the robot is commonly used in conjunction with an automated system, dangerous situations are more likely to occur from the automated system than from the robot itself. Accordingly, appropriate safety measures must be taken on the part of the system manufacturer according to the individual system. The system manufacturer should provide a proper instruction manual for safe, correct operation and servicing of the system.

6 Trial Operation

After making installations, adjustments, inspections, maintenance or repairs to the robot, make a trial run using the following procedures.

(1) If a safeguard enclosure has not yet been provided right after installation of the robot, rope off or chain off around the movement area of the manipulator in place of the safeguard enclosure, and observe the following points.
   1. Use sturdy, stable posts which will not fall over easily.
   2. The rope or chain should be easily visible by everyone around the robot.
   3. Place a sign to keep the operator or other personnel from entering the movement range of the manipulator.

(2) Check the following points before turning on the controller.
   1. Is the robot securely and correctly installed?
   2. Are the electrical connections to the robot correct?
   3. Are items such as air pressure correctly supplied?
   4. Is the robot correctly connected to peripheral equipment?
   5. Have safety measures (safeguard enclosure, etc.) been taken?
   6. Does the installation environment meet the specified standards?

(3) After the controller is turned on, check the following points from outside the safeguard enclosure.
   1. Does the robot start and stop as intended? Can the operation mode be selected correctly?
   2. Does each axis move as intended within the soft limits?
   3. Does the end effector move as intended?
   4. Are the signal transmissions to the end effector and peripheral equipment correct?
   5. Does emergency stop work?
   6. Are the teaching and playback functions normal?
   7. Are the safeguard enclosure and interlock working as intended?
   8. Does the robot move correctly during automatic operation?

7 Work Within the Safeguard Enclosure

(1) When work is required inside the safeguard enclosure, always turn off the controller and place a sign indicating that the robot is being adjusted or serviced in order to keep any other person from touching the controller switch or operation panel, except for the following cases.
 1) Origin position setting (See Section 3 in Chapter 4.)
 2) Soft limit settings (See Section 4 in Chapter 4.)
 3) Standard coordinate settings (See Section 5 in Chapter 4.)
 4) Teaching

 For items 1) to 3), follow the precautions and procedure for each section. To perform item 4), refer to the description in (2) below.

(2) Teaching
 When performing teaching within the safeguard enclosure, comply with the instructions listed below.
 1) Check or perform the following points from outside the safeguard enclosure.
  1. Make sure that no hazards are present within the safeguard enclosure by a visual check.
  2. Check that the programming unit MPB operates correctly.
  3. Check that no failures are found in the robot.
  4. Check that emergency stop works correctly.
  5. Select teaching mode and prohibit automatic operation.
 2) Never enter the movement range of the manipulator while within the safeguard enclosure.

8 Automatic Operation

Automatic operation described here includes all operations in AUTO mode.

(1) Check the following before starting automatic operation.
    1. No one is within the safeguard enclosure.
    2. The programming unit and tools are in their specified locations.
    3. The alarm or error lamps on the robot and peripheral equipment do not flash.
    4. The safeguard enclosure is securely installed with safety interlocks actuated.

(2) Observe the following during automatic operation or in cases where an error occurs.
    1) After automatic operation has started, check the operation status and warning lamp to ensure that the robot is in automatic operation.
    2) Never enter the safeguard enclosure during automatic operation.
    3) If an error occurs in the robot or peripheral equipment, observe the following procedure before entering the safeguard enclosure.
        1. Press the emergency stop button to set the robot to emergency stop.
        2. Place a sign on the start switch, indicating that the robot is being inspected in order to keep any other person from touching the start switch and restarting the robot.

9 Adjustment and Inspection

Do not attempt any installation, adjustment, inspection or maintenance unless it is described in this manual.

10 Repair and Modification

Do not attempt any repair, parts replacement and modification unless described in this manual. These works require technical knowledge and skill, and may also involve work hazards.

11 Warranty

The YAMAHA robot and/or related product you have purchased are warranted against the defects or malfunctions as described below.

Warranty description : If a failure or breakdown occurs due to defects in materials or workmanship in the genuine parts constituting this YAMAHA robot and/or related product within the warranty period, then YAMAHA will repair or replace those parts free of charge (hereafter called "warranty repair").

Warranty Period : The warranty period ends when any of the following applies:
(1) After 18 months (one and a half year) have elapsed from the date of shipment
(2) After one year has elapsed from the date of installation
(3) After 2,400 hours of operation

Exceptions to the Warranty : This warranty will not apply in the following cases:
(1) Fatigue arising due to the passage of time, natural wear and tear occurring during operation (natural fading of painted or plated surfaces, deterioration of parts subject to wear, etc.)
(2) Minor natural phenomena that do not affect the capabilities of the robot and/or related product (noise from computers, motors, etc.).
(3) Programs, point data and other internal data that were changed or created by the user.

Failures resulting from the following causes are not covered by warranty repair.

1) Damage due to earthquakes, storms, floods, thunderbolt, fire or any other natural or man-made disasters.
2) Troubles caused by procedures prohibited in this manual.
3) Modifications to the robot and/or related product not approved by YAMAHA or YAMAHA sales representatives.
4) Use of any other than genuine parts and specified grease and lubricants.
5) Incorrect or inadequate maintenance and inspection.
6) Repairs by other than authorized dealers.

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12 CE Marking

When the YAMAHA robots are exported to or used in EU (European Union) countries, refer to the separate "YAMAHA Robot Controller User's Manual" or "CE marking manual" for related information about CE marking.

CHAPTER 2

Functions

1 Robot Manipulator 2-1
2 Robot Controller 2-3
3 Robot Initialization Number List 2-4

MEMO

1 Robot Manipulator

The YK-XG series robots are available in 4-axis models having an X/Y-axis arm (equivalent to human arm) and a Z/R-axis (equivalent to human wrist). With these 4 axes, the YK-XG series robots can move as shown in Fig. 2-1. By attaching different types of end effector (gripper) to the end of the arm, a wide range of tasks can be performed with high precision at high speeds. The (+) and (-) signs show the direction of axis movement when the jog keys on the programming unit are pressed (standard setting at the factory). Fig. 2-2 on the subsequent pages show part names and functions of each robot model.

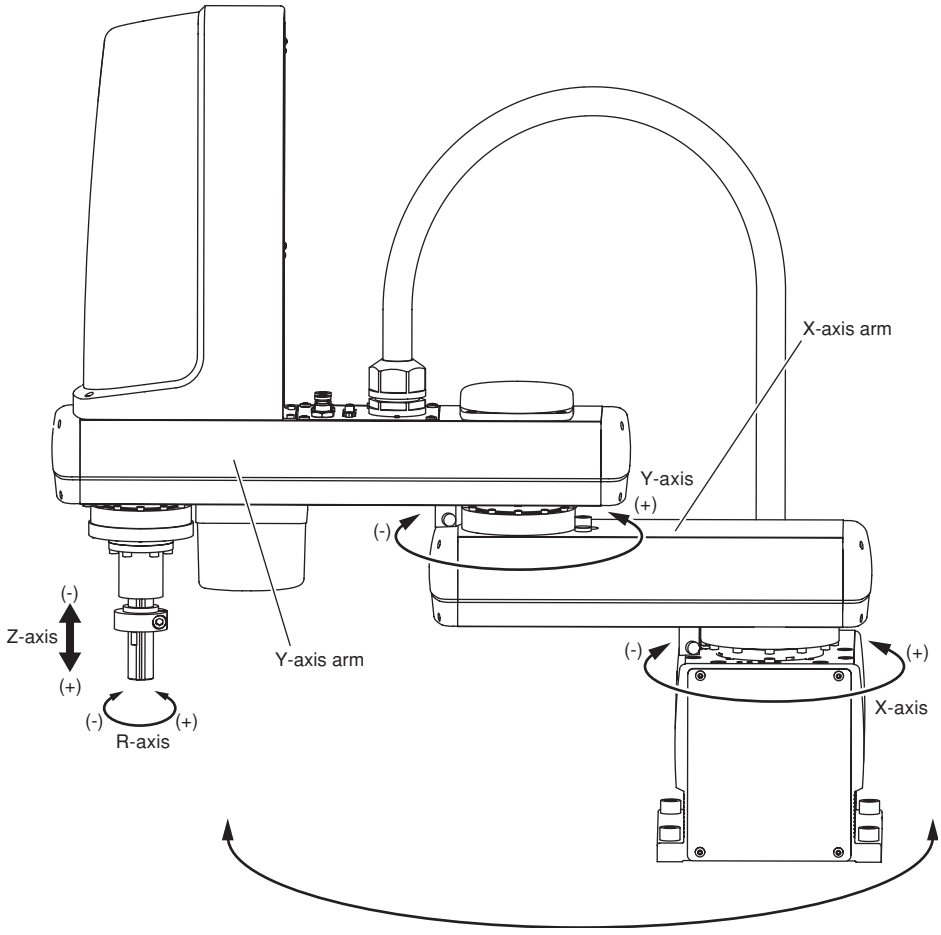


Fig. 2-1 Manipulator movement

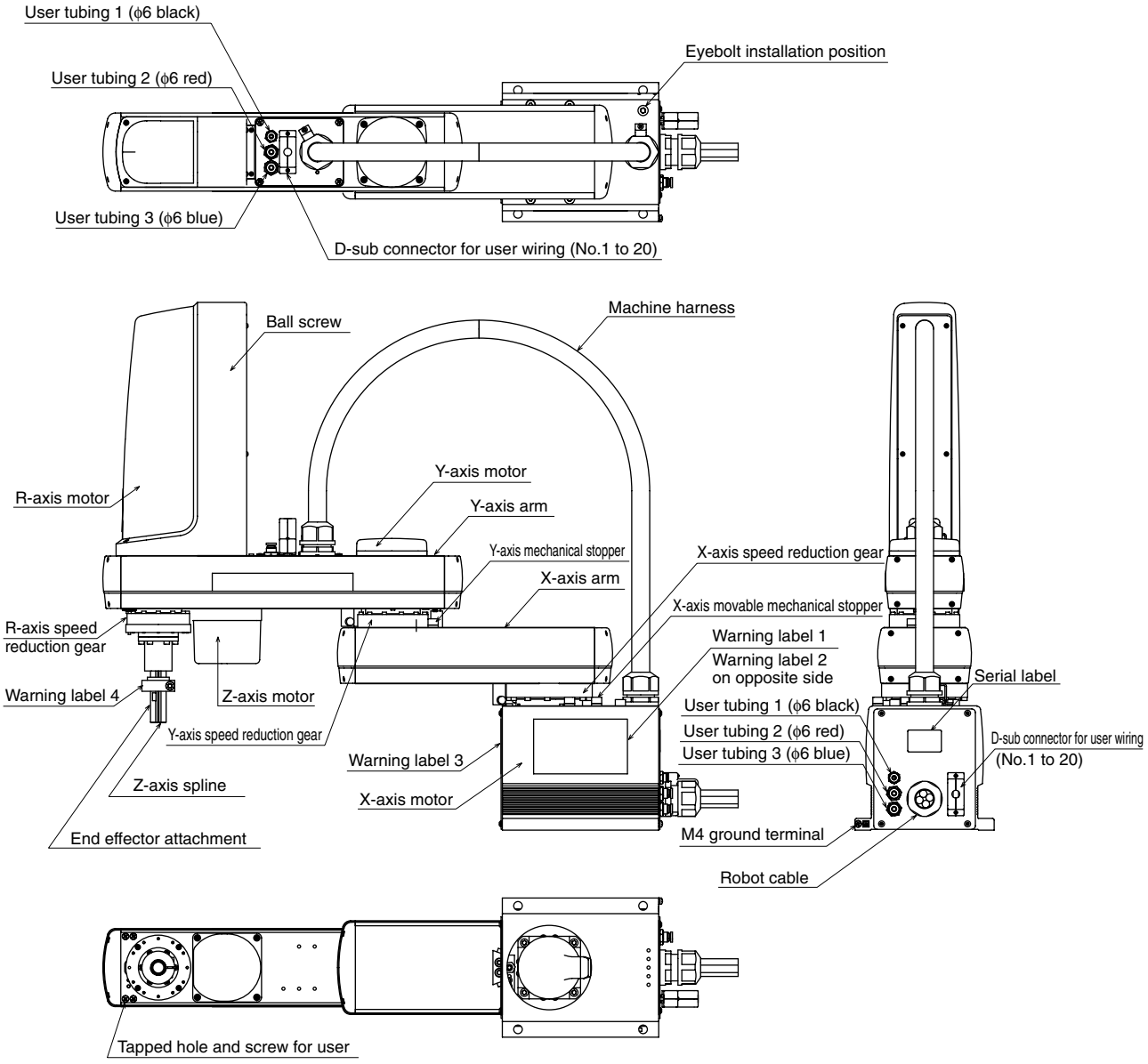
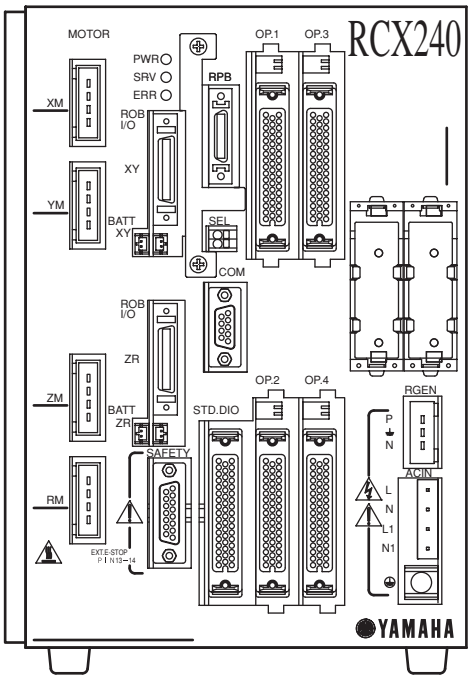


Fig. 2-2 YK500XG, YK600XG, YK600XGH, YK700XG, YK800XG, YK900XG, YK1000XG

2 Robot Controller

The YK-XG series robot comes supplied with a robot controller RCX240. For more details, refer to the separate "YAMAHA Robot Controller User's Manual".



RCX240

Fig. 2-3 Robot controller

3 Robot Initialization Number List

The YK-XG series robots are initialized for optimum setting (default setting) according to the robot model prior to shipping. The robot controllers do not have to be reinitialized during normal operation. However, if for some reason the controller must be reinitialized, proceed while referring to the list below.

⚠CAUTION

- Absolute reset must be performed after reinitializing the controller.
  Before reinitializing the controller, read the descriptions in "3. Adjusting the origin" in Chapter 4 and make sure you thoroughly understand the procedure.
- When the controller is initialized, the "ARM LENGTH" and "OFFSET PULSE" settings in the axis parameters will be erased, making the standard coordinate settings invalid. (For details on standard coordinates, see "5. Setting the Standard Coordinates" in Chapter 4.) If you do not want to change the origin position by initializing, make a note of the "ARM LENGTH" and "OFFSET PULSE" settings before initializing, and re-enter their settings after initialization is complete.

Robot initialization number	Model name
2117	YK500XG Z200
2118	YK500XG Z300
2119	YK600XG Z200
2120	YK600XG Z300
2121	YK600XGH Z200
2122	YK600XGH Z400
2123	YK700XG Z200
2124	YK700XG Z400
2125	YK800XG Z200
2126	YK800XG Z400
2127	YK900XG Z200
2128	YK900XG Z400
2129	YK1000XG Z200
2130	YK1000XG Z400

CHAPTER 3

Installation

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MEMO

1 Robot Installation Conditions

1-1 Installation environments

Be sure to install the robot in the following environments.

Setting environments	Specifications
Allowable ambient temperature	0 to 40°C
Allowable ambient humidity	35 to 85% RH (non condensation)
Altitude	0 to 1000 meters above sea level
Ambient environments	Avoid installing near water, cutting water, oil, dust, metallic chips and organic solvent.
	Avoid installation near corrosive gas and corrosive materials.
	Avoid installation in atmosphere containing inflammable gas, dust or liquid.
	Avoid installation near objects causing electromagnetic interference, electrostatic discharge or radio frequency interference.
Vibration	Do not subject to impacts or vibrations.
Air supply pressure, etc.	Below 0.58MPa (6.0kgf/cm^2); clean dry air not containing deteriorated compressor oil; filtration 40 m or less
Working space	Allow sufficient space margin to perform jobs (teaching, inspection, repair, etc.)

For detailed information on how to install the robot controller, refer to the separate "YAMAHA Robot Controller User's Manual".

⚠ WARNING

- Avoid installing the robot in locations where the ambient conditions may exceed the allowable temperature or humidity, or in environments where water, corrosive gases, metallic powder or dust are generated. Malfunction, failure or short circuits may otherwise result.
- This robot was not designed for operation in environments where inflammable or explosive substances are present. Do not use the robot in environments containing inflammable gas, dust or liquids. Explosions or fire could otherwise result.
- Avoid using the robot in locations subject to electromagnetic interference, electrostatic discharge or radio frequency interference. Malfunction may otherwise occur.
- Do not use the robot in locations subject to excessive vibration. Robot installation bolts may otherwise become loose causing the manipulator to fall over.

1-2 Installation base

⚠WARNING

- Install the robot on a horizontal surface, with the base mount section facing down. If installed by other methods with the base mount section not facing down, grease might leak from the reduction gear unit.
- Do not place the robot on a moving installation base. Excessive loads will be applied to the robot arm by movement of the installation base, resulting in damage to the robot.

⚠CAUTION

- The manipulator positioning might decrease if the installation surface precision is insufficient.
- If the installation base is not sufficiently rigid and stable or a thin metallic plate is attached to the installation base, vibration (resonance) may occur during operation, causing detrimental effects on the manipulator work.

1) Prepare a sufficiently rigid and stable installation base, taking account of the robot weight including the end effector (gripper), workpiece and reaction force while the robot is operating. The maximum reaction force (see Fig. 3-1) applied to the X-axis and Z-axis of each robot during operation is shown in the table below. These values are an instantaneous force applied to the robot during operation and do not indicate the maximum load capacity.

The maximum reaction force

	Fxmax		Mxmax		Fzmax	
Robot Model	N	kgf	Nm	kgfm	N	kgf
YK500XG	1416	144	178	18	134	14
YK600XG	1476	150	178	18	134	14
YK600XGH	2125	217	395	40	205	21
YK700XG	2479	253	395	40	239	24
YK800XG	2561	261	395	40	239	24
YK900XG	2494	254	395	40	165	17
YK1000XG	2427	248	395	40	165	17

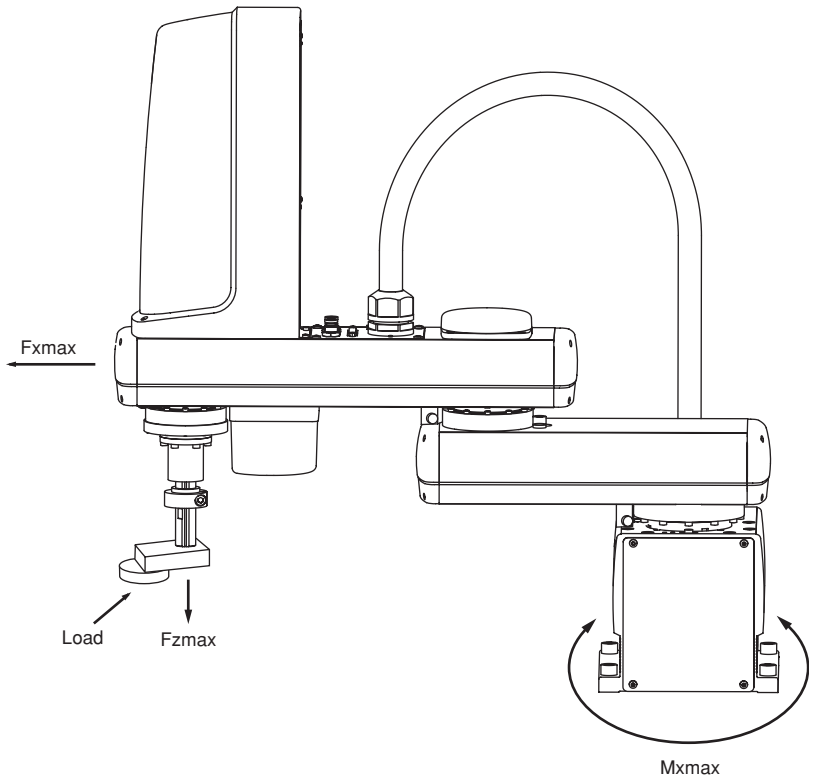


Fig. 3-1 Maximum reaction force applied during operation

2) The parallelism of the installation base surface must be machined within a precision of ±0.05mm/500mm. The robot base mount must be installed facing down and in a level position (except ceiling-mount models which should be installed with the base mount facing up).
3) Tap holes into the surface of the installation base. For machining dimensions and positions, refer to “1-2 External view and dimensions” in Chapter 7.
4) Securely fix the installation base on the floor with anchor bolts.

2 Installation

2-1 Unpacking

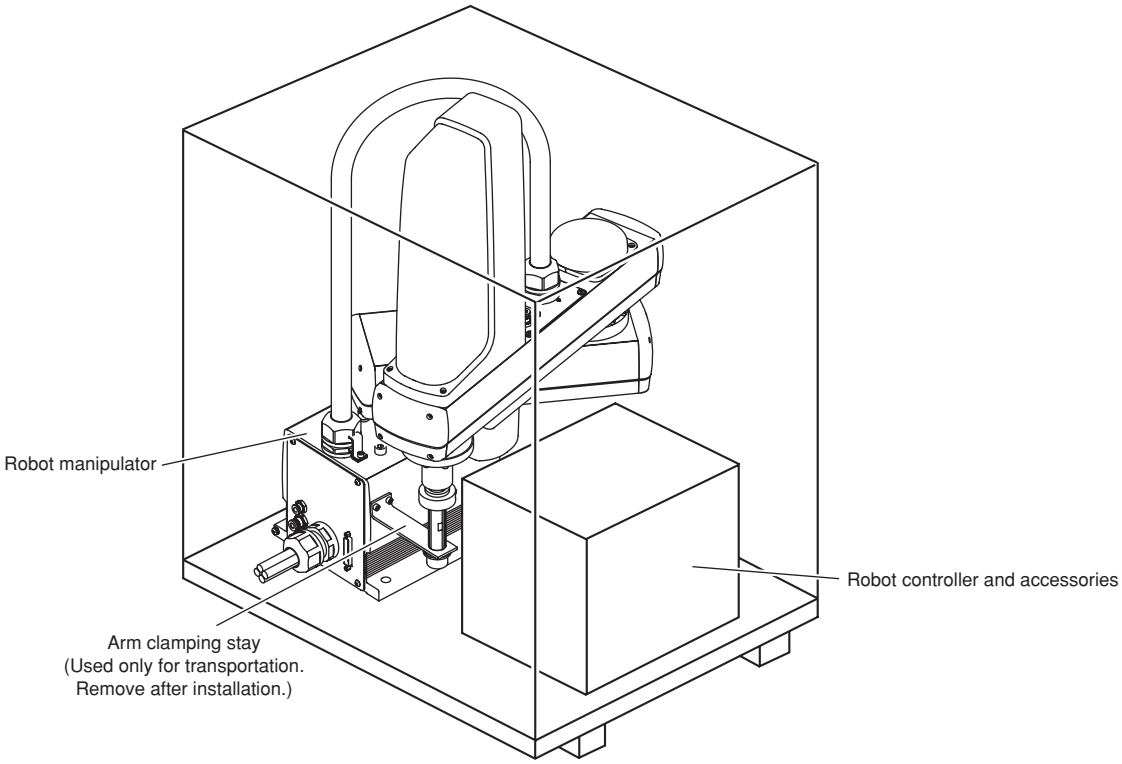
⚠WARNING

The robot and controller are heavy. Take sufficient care not to drop them during moving or unpacking as this may damage the equipment or cause bodily injury.

⚠CAUTION

When moving the robot or controller by equipment such as a folklift that require a license, only properly qualified personnel may operate it. The equipment and tools used for moving the robot should be serviced daily.

The YK-XG series robot comes packed with a robot controller and accessories, according to the order specifications. Using a carrying cart (dolly) or forklift, move the package to near the installation base. Take sufficient care not to apply shocks to the equipment when unpacking it.



YK500XG, YK600XG, YK600XGH, YK700XG, YK800XG, YK900XG, YK1000XG

Fig. 3-2 Packed state

2-2 Checking the product

After unpacking, check the product configuration and conditions.
The following configurations are typical examples, so please check that the product is as specified in your order.

⚠CAUTION

If there is any damage due to transportation or insufficient parts, please notify your YAMAHA sales office or dealer immediately.

Controller : RCX240
Robot : YK500XG, YK600XG, YK600XGH, YK700XG, YK800XG, YK900XG, YK1000XG

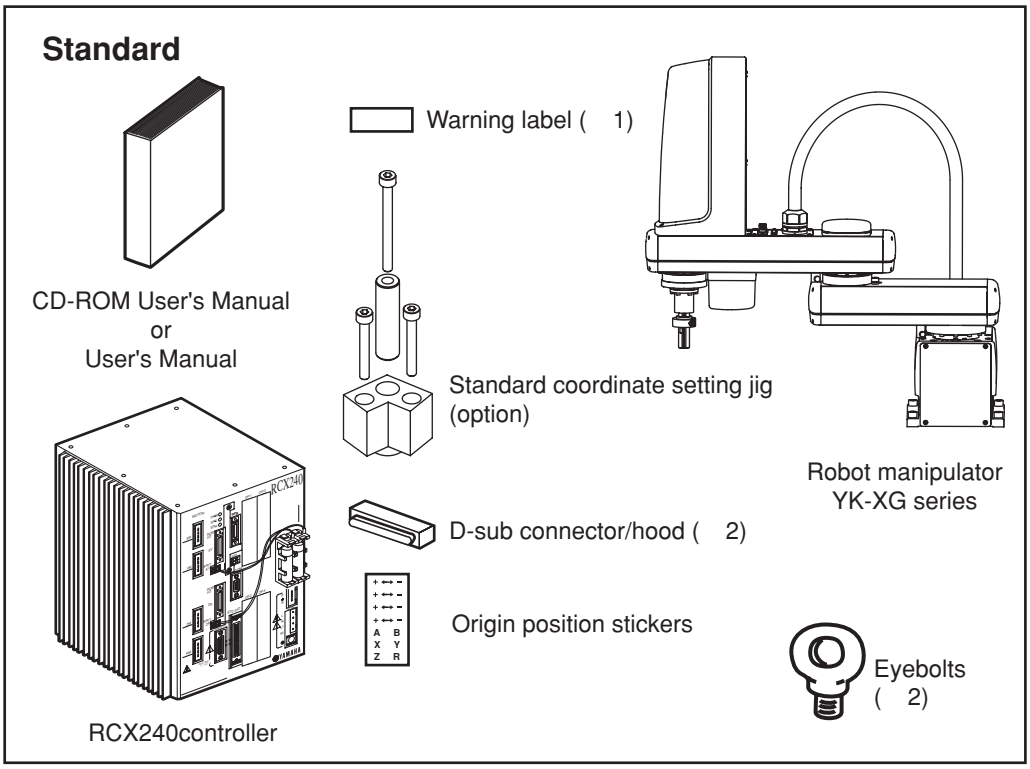


Fig. 3-3 Product configurations

2-3 Moving the robot

⚠WARNING

Serious injury may occur if the robot falls and pins someone under it.
- Do not allow any part of your body to enter the area beneath the robot during work.
- Always wear a helmet, safety shoes and gloves during work.

To check the mass of each robot, refer to "1-1 Basic specifications" in Chapter 7.

2-3-1 Moving the YK500XG, YK600XG, YK600XGH, YK700XG, YK800XG, YK900XG, YK1000XG

⚠WARNING

Serious injury may occur if the robot falls and pins someone under it.
- Check that there are no cracks and corrosion on the eyebolt installation. If found, do not use eyebolts to move the robot.
- Screw the eyebolts securely into the tapped holes until the bearing surface of eyebolt makes tight contact with the bearing surface on the arm.
- Use a hoist and rope with carrying capacity strong enough to support the robot weight.
- Make sure the rope stays securely on the hoist hook.
- Remove all loads attached to the robot manipulator end. If any load is still attached, the robot may lose balance while being carried, and topple over causing accidents.

⚠CAUTION

- When moving the robot by equipment such as cranes that require a license, only properly qualified personnel may operate it.
- The equipment and tools used for moving the robot should be serviced daily.

To move a robot (for example, the YK500XG) correctly and safely, follow the procedure below. (See Fig. 3-4.) Use the same procedure to move other robots.

1) Lower the Z-axis to a point approximately 24mm (35mm for YK600XGH or longer arm robots) lower than the origin position. Then turn off the controller and unplug the robot cable from the controller. (The Z-axis is fixed to the base with an arm clamp stay at the factory prior to shipment.)
2) Remove the bolts on the X-axis arm.
3) Fold the X and Y-axis arms as shown in the drawing, and clamp the Y axis arm to the robot base by using the stay, bolts and washers (2 washers for YK500XG and YK600XG; 1 washer for YK600XGH or longer arm robots) that come with the robot.
   If the arms cannot be folded in the carrying position due to the X-axis mechanical stoppers, then remove them. (When the robot is shipped, the mechanical stoppers are installed to provide the maximum movement range.)

4) Screw the two eyebolts through washers into the upper surface of the X-axis arm.
5) Wind the robot cable around the upper part of the robot base so that it does not hang up on the base mount, then fasten the cable end with adhesive tape.
6) Prepare two looped ropes with the same length to allow a good lifting balance, then pass each rope through each eyebolt and catch it on the hoist hook.
7) Slightly lift the hoist so that each rope has light tension to hold the robot. In this state, remove the bolts securing the robot base to the pallet supplied or installation base (if robot is to be moved to another installation base).
8) Using caution to keep the balance of the robot and avoid subjecting it to any strong vibrations and shocks, operate the hoist carefully to move to the installation base. The angle between each rope and the arm surface should be kept at 45 degrees or more.
9) Slightly lower the robot on the installation base and temporarily secure it by tightening the bolts.
   (For tightening torque to secure the robot firmly, see the next section, "2-4 Installing the robot".)
10) Remove the rope, eyebolts and arm clamp stay. Screw the bolts into the upper surface of the X-axis. (Always attach these bolts to protect the eyebolt hole threads.) Be sure to keep the eyebolts, arm clamp stay, bolts and pallet, since they may be used to move the robot again.

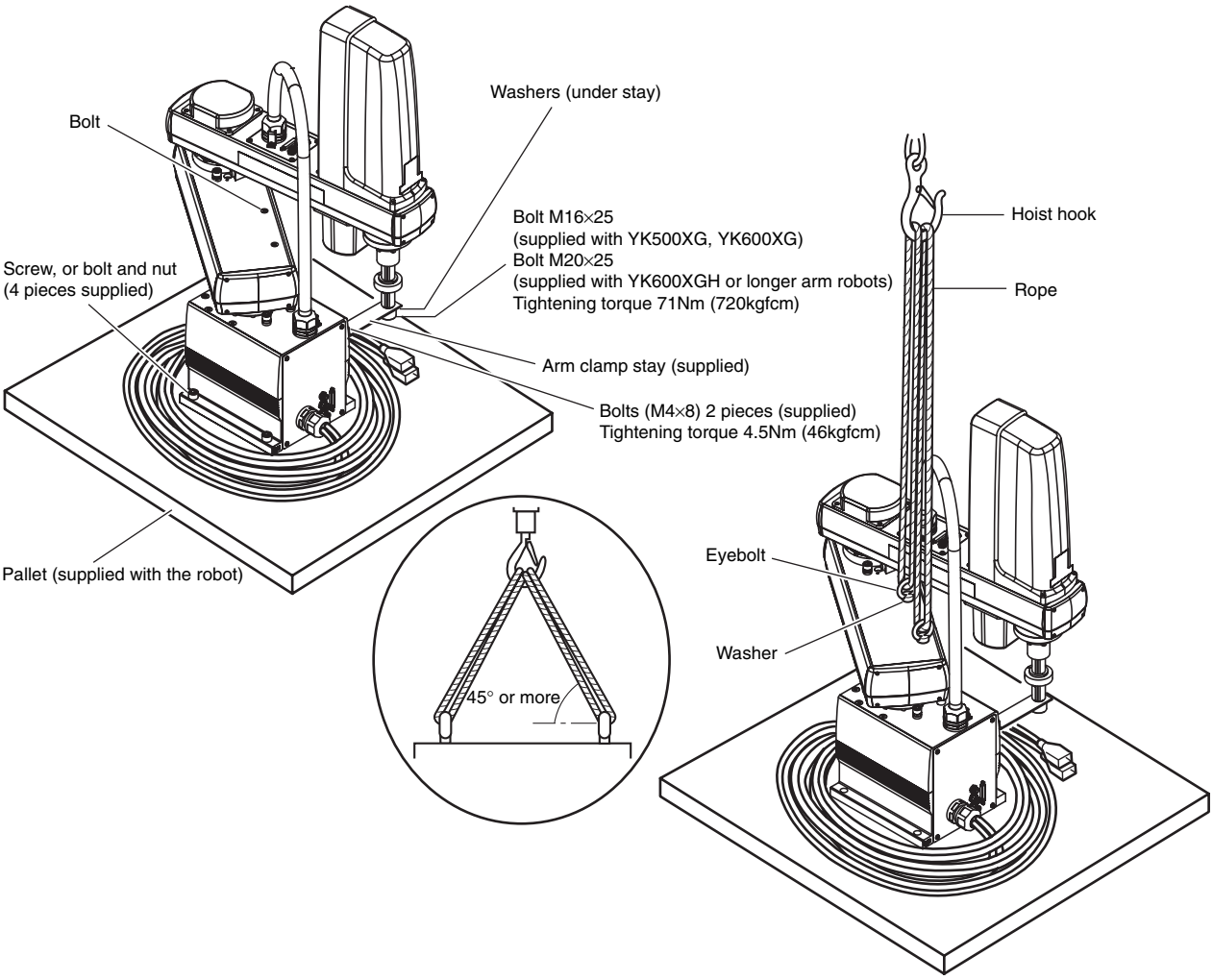


Fig. 3-4

2-4 Installing the robot

Install the robot securely with the four hex socket head bolts as shown in Fig. 3-5.

⚠ WARNING

When installing the robot, be sure to use the specified size and quantity of bolts that match the depth of tapped holes in the installation base, and securely tighten the bolts to the correct torque. If the bolts are not tightened correctly, the robot might fall over during operation causing a serious accident.

Tightening torque

Robot Model	Bolts Used	Tightening torque
YK500XG, YK600XG	M10	71Nm (720kgfcm)
YK600XGH, YK700XG, YK800XG, YK900XG, YK1000XG	M12	128Nm (1310kgfcm)

Depth of tapped holes in installation base:

Iron installation base	Bolt diameter × 1.5 or more
Aluminum installation base	Bolt diameter × 3 or more
Recommended bolt	JIS B 1176 hex socket head bolt, or equivalent Strength class JIS B 1051 12.9, or equivalent

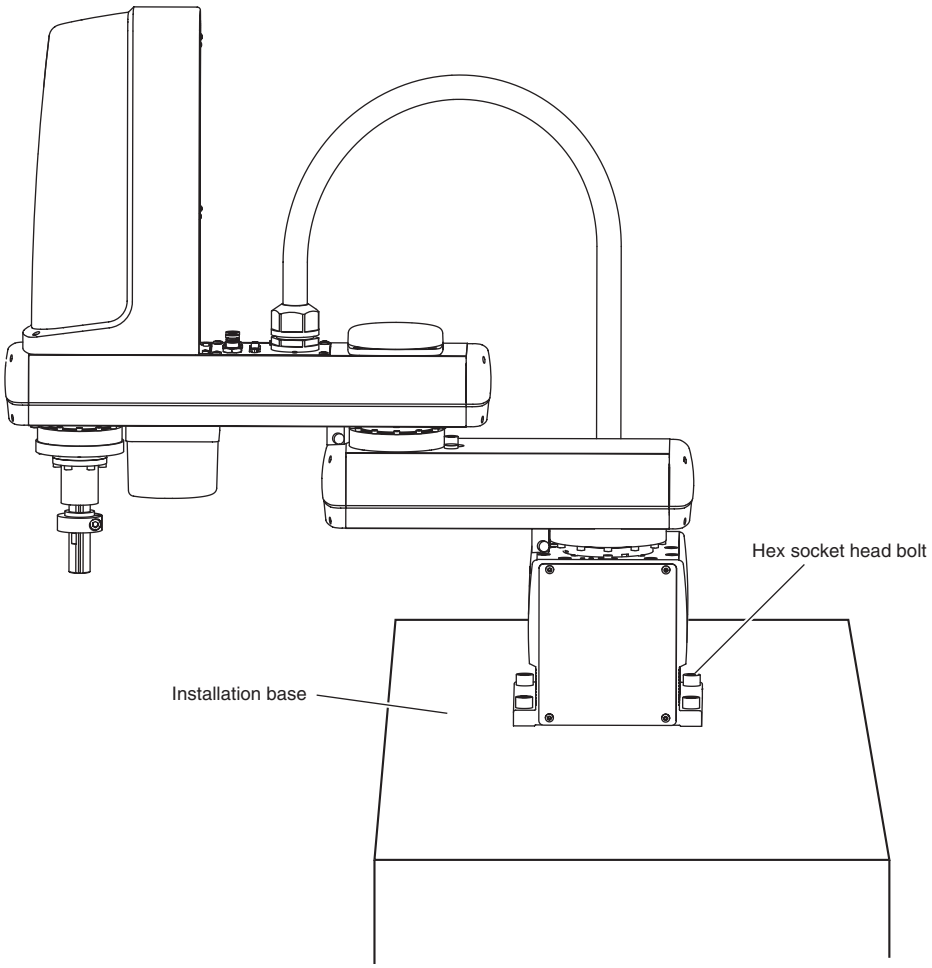


Fig. 3-5 Installing the robot

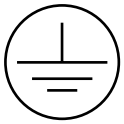
3 Protective Bonding

⚠ WARNING

- Be sure to ground the robot and controller to prevent electrical shock.
- Turn off the controller before grounding the robot.

The robot must be grounded as follows:

1) Provide a terminal marked "PE" for the protective conductor of the entire system and connect it to an external protective conductor. In addition, securely connect the ground terminal on the robot pedestal to the same protective conductor. (See Fig. 3-6 for example of the YK500XG.)



(Symbol 417-IEC-5019)

2) When the end effector uses an electrical device which, if it malfunctions, might make contact with the power supply, the user must provide proper grounding on his own responsibility. The YK-XG series robots do not have a ground terminal for this purpose.

3) For details on protective bonding on the robot body to comply with CE Marking, follow the instructions on protective bonding explained in the "YAMAHA Robot Controller User's Manual" or "CE Marking manual".

4) Use a ground cable with a conductor wire cross section of at least 2.0mm^2 and a length within 1 meter.

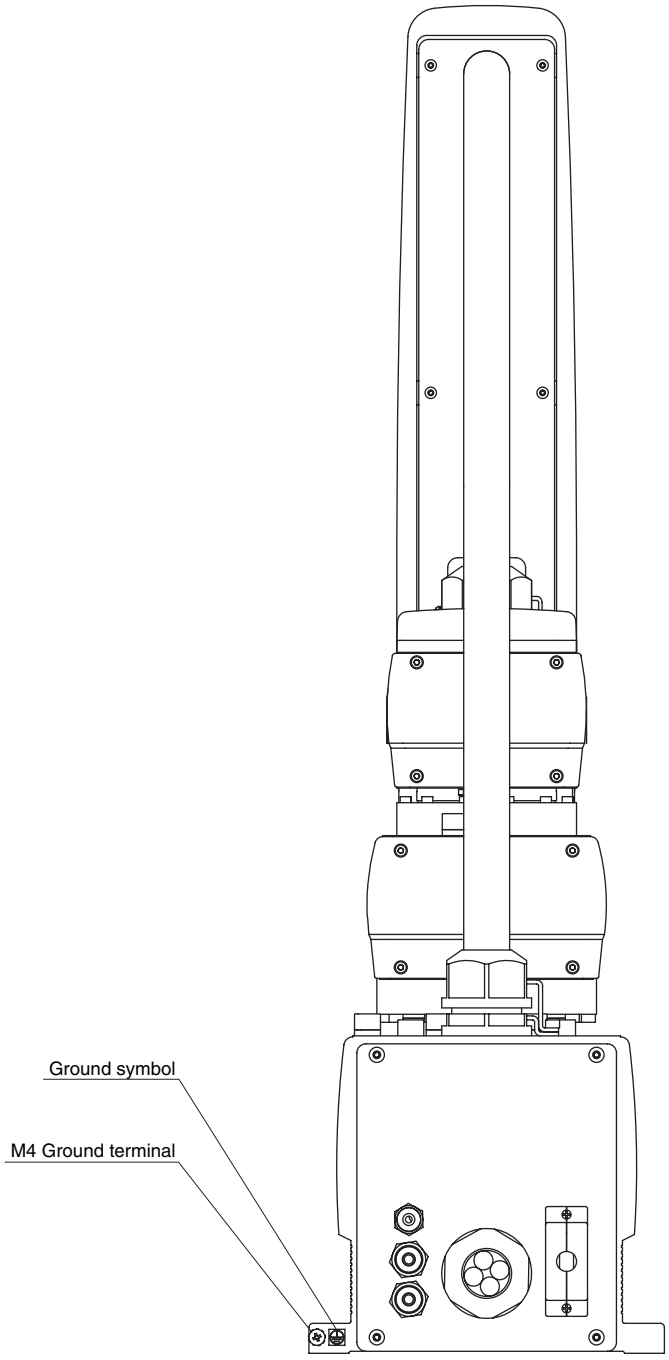


Fig. 3-6 Ground terminal

4 Robot Cable Connection

The robot cable is pre-connected to the YK-XG series robot. For details on connections to the robot controller, refer to Fig. 3-7 and the "YAMAHA Robot Controller User's Manual". After making connections, check the operation while referring to "6 Trial operation" in Chapter 1.

⚠ WARNING

- Before connecting the cables, check that there are no bends or breaks in the connector pins of the robot cable and that the cables are not damaged. Bent or broken pins or cable damage may cause malfunction of the robot.
- Ensure that the controller is off before connecting the robot cable to the controller.
- In the RCX240 controller, the MOTOR connectors XM and ZM, and YM and RM each have identical shapes. In addition, the PI connectors XY and ZR have identical shapes. Do not confuse these connectors when making connections. Wrong connections may result in malfunction and hazardous situations.
- If the connector installation is inadequate or if there are contact failures in the pins, the robot may malfunction causing a hazardous situation. Reconfirm that each connector is securely installed before turning on the controller.
- To attach the PI connector securely, tighten the screws supplied with the robot.
- Take caution not to apply an excessive load to the connectors due to stress or tension on the cables.
- Lay out the cables so that they do not obstruct the movement of the manipulator. Determine the robot work area in which the robot cables will not interfere with the load or workpiece picked up by the manipulator. If the robot cables interfere with the movable parts of the robot, the cables may be damaged causing malfunction and hazardous situations. Refer to “1-2 External view and dimensions” in Chapter 7.
- Lay out the robot cables so as to keep the operator or any other person from tripping on them. Bodily injury may result if someone trips on the cables.

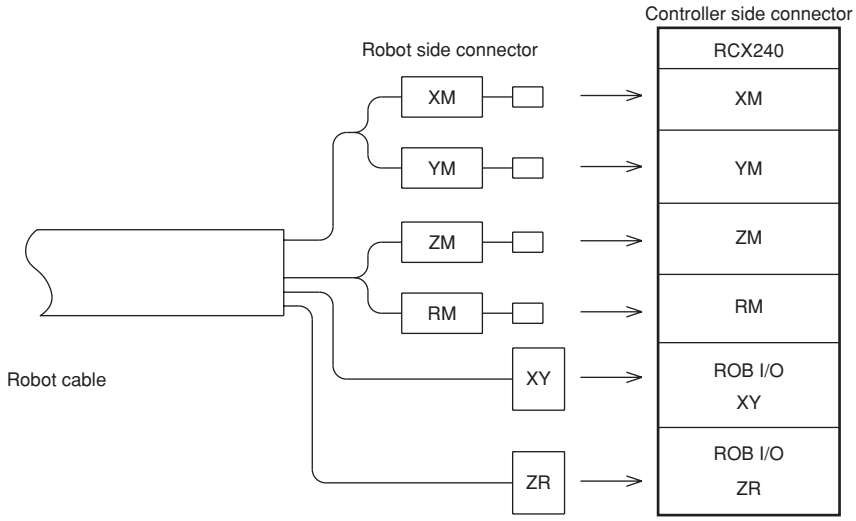


Fig. 3-7 Robot cable connections

5 User Wiring and User Tubing

⚠ WARNING

Always turn off the controller and shut off air supply before attempting wiring and piping work. If air or power is supplied during this work, the manipulator may move erroneously causing a hazardous situation.

1) The YK-XG series robots are equipped with user wires and air tubes in the machine harness. The table below shows the number of wires and air tubes available for each robot model.

Robot model	User wiring	User tubing
YK500XG, YK600XG, YK600XGH, YK700XG, YK800XG, YK900XG, YK1000XG	20 wires	ϕ6, 3 tubes

(Robot models for custom specifications may have different wiring or tubing.)
The specifications of the user wires and air tubes are shown below. Always observe the specifications.

User Wiring

Rated voltage	30V
Allowable current	1.5A
Nominal cross-section area of conductor	0.2mm^2
Shield	Yes

User Tubing

Maximum pressure	0.58MPa (6Kgf/cm^2)
Outer diameter × inner diameter	ϕ6mm×ϕ4mm
Fluid	Dry clean air not containing deteriorated compressor oil; filtration 40μm or less

2) A D-sub connector for user wiring and a bulkhead union for user tubing are provided one each on the arm side and pedestal side. For the locations, refer to “1-2 External view and dimensions” in Chapter 7.

3) Signal wiring connections in the machine harness

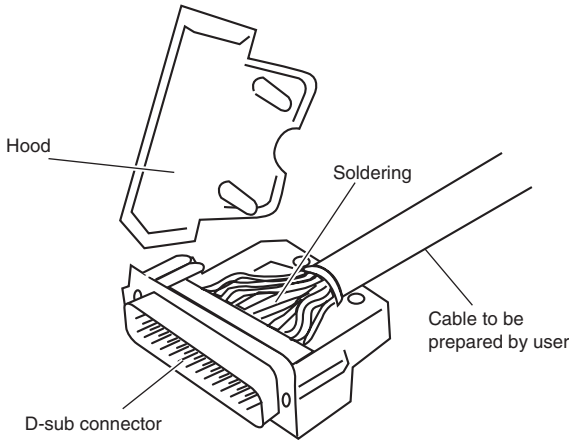
1. YK500XG, YK600XG

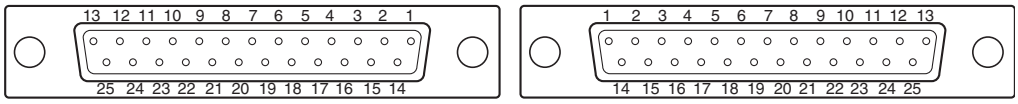
Connector pins 1 to 20 can be used. Pin 25 is connected to a shield wire and cannot be used as a signal wire.

Signal	Connector	NO	Connection	NO	Connector	Color
User signal line	I O (Arm side)	1		1	I O (Base side)	Brown
		2		2		Red
		3		3		Orange
		4		4		Blue
		5		5		Violet
		6		6		Grey
		7		7		White
		8		8		Black
		9		9		Brown
		10		10		Red
		11		11		Orange
		12		12		Blue
		13		13		Brown
		14		14		Red
		15		15		Orange
		16		16		Blue
		17		17		Violet
		18		18		Grey
		19		19		White
		20		20		Black
		21		21		
		22		22		
		23		23		
		24		24		
Shield		25		25		Green
Flame Ground				1	FG	Green

(Robots models with non-standard specifications may have different wiring colors.)

4) As shown in Fig. 3-8, solder the user cable wires to the D-sub connector (supplied with the robot). Reattach the hood to the D-sub connector after soldering, then plug it into the user wiring connector.
The connector pinouts as viewed from the solder side are shown below.





D-sub connector on arm side
(As viewed from solder side)

D-sub connector on base side
(As viewed from solder side)

YK500XG, YK600XG, YK600XGH, YK700XG, YK800XG, YK900XG, YK1000XG

Fig. 3-8

⚠ WARNING

- The user cable wires should have a shield wire. Connect it to the same No. pin in the D-sub connector on the robot side, which also connects to the shield wire. If this task is omitted, noise may cause malfunction of the robot.
- Securely attach the D-sub connector (supplied with the robot) into the D-sub connector on the robot side, by tightening the screws on the connector hood. If this connector comes loose or comes off, malfunction may result.
- Avoid fastening the user cable or tube with the machine harness, as this may lead to harness breakage and malfunction.
- Make sure that the user cable attached to the D-sub connector for user wiring and the tube attached to the bulkhead union for user tubing will not interfere with the robot movement, entangle around the robot or flap around during operation. Wiring and tubing might then be damaged causing malfunction of the robot.
- Lay out the user cable attached to the D-sub connector for user wiring and the tube attached to the bulkhead union for user tubing so that they do not obstruct the movement of the operator or any other persons. Bodily injury may result if anyone trips on the cable or air tube.

⚠CAUTION

- The D-sub connector supplied with the robot should be connected to the arm side by pin contact, and to the pedestal side by socket contact. Use caution at these points when soldering.
- Be sure to use the D-sub connector and hood which are supplied with the robot. Using other types may result in contact failure.

D-sub connectors (supplied with robot)

Robot model	D-sub connector on arm side	D-sub connector on base side	Hood
YK500XG, YK600XG, YK600XGH, YK700XG, YK800XG, YK900XG, YK1000XG	DB-25P-NR	DB-25S-NR	DB-C2-J9R

Manufacturer : Japan Aviation Electronics Industry, Limited.

5) To check the operation and signal transmission between the end effector and the controller or peripheral equipment after making connections, refer to "6. Trial operation" in Chapter 1.

6 Attaching the End Effector

6-1 R-axis tolerable moment of inertia and acceleration coefficient

1) The moment of inertia of a load (end effector and workpiece) that can be attached to the R-axis is limited by the strength of the robot drive unit and residual vibration during positioning. It is therefore necessary to reduce the acceleration coefficient in accordance with the moment of inertia.

2) The R-axis tolerable moment of inertia and the acceleration coefficient versus R-axis moment of inertia for each robot model are shown in Fig. 3-9 to Fig. 3-13 on the subsequent pages. The symbols A_X, A_Y, and A_R in each figure respectively indicate the acceleration coefficients of the X-axis, Y-axis and R-axis. The symbol I_R (J_R) is the moment of inertia of the load around the R-axis and m is the tip mass.

   Example: YK500XG
   Assume that the mass of the load installed to the R-axis is 1.5kg and the moment of inertia around the R-axis is 0.1kgm^2 (1.0kgfcmsec^2). When the tip mass parameter is set to 2kg, the robot can be operated by reducing the X, Y and R-axis acceleration coefficients to 62%, as can be seen from Fig. 3-9. Be sure to select an optimum tip mass and acceleration coefficient parameters that meet the mass of the load and moment of inertia before using the robot. To make settings for the tip mass and acceleration coefficient, refer to the separate "YAMAHA Robot Controller User's Manual".

3) Methods for calculating the moment of inertia of the load are shown in Section 6-2, however, it is not easy to precisely figure out these values. If a calculated value smaller than the actual moment of inertia is set, residual vibrations may occur. If this happens, reduce the acceleration coefficient parameter even further.

⚠CAUTION

- The robot must be operated with correct tolerable moment of inertia and acceleration coefficients according to the manipulator tip mass and moment of inertia. If this is not observed, premature end to the life of the drive units, damage to the robot parts or residual vibration during positioning may result.
- Depending on the Z-axis position, vibration may occur when the X, Y or R-axis moves. If this happens, reduce the X, Y or R-axis acceleration to an appropriate level.
- If the moment of inertia is too large, vibration may occur on the Z-axis depending on its operation position. If this happens, reduce the Z-axis acceleration to an appropriate level.

6-1-1 Acceleration coefficient vs. moment of inertia (YK500XG)

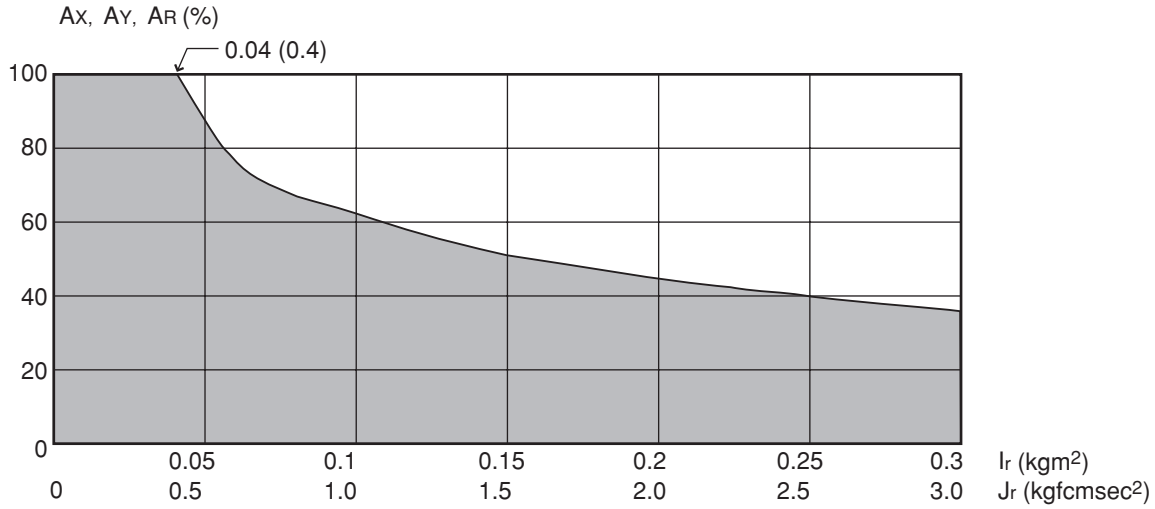


Fig. 3-9 m=1 to 10kg

6-1-2 Acceleration coefficient vs. moment of inertia (YK600XG)

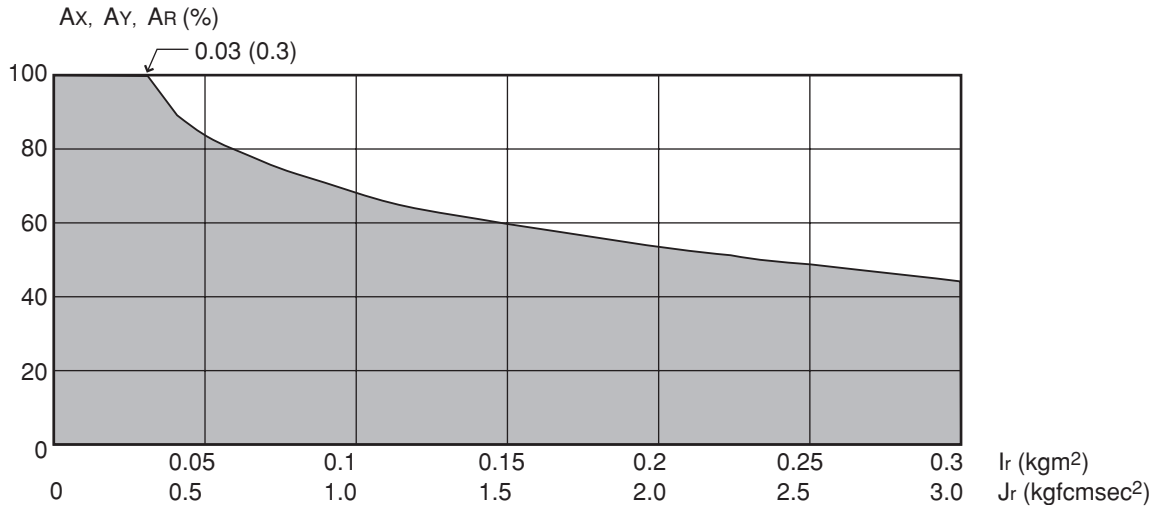


Fig. 3-10 m=1 to 10kg

6-1-3 Acceleration coefficient vs. moment of inertia (YK600XGH)

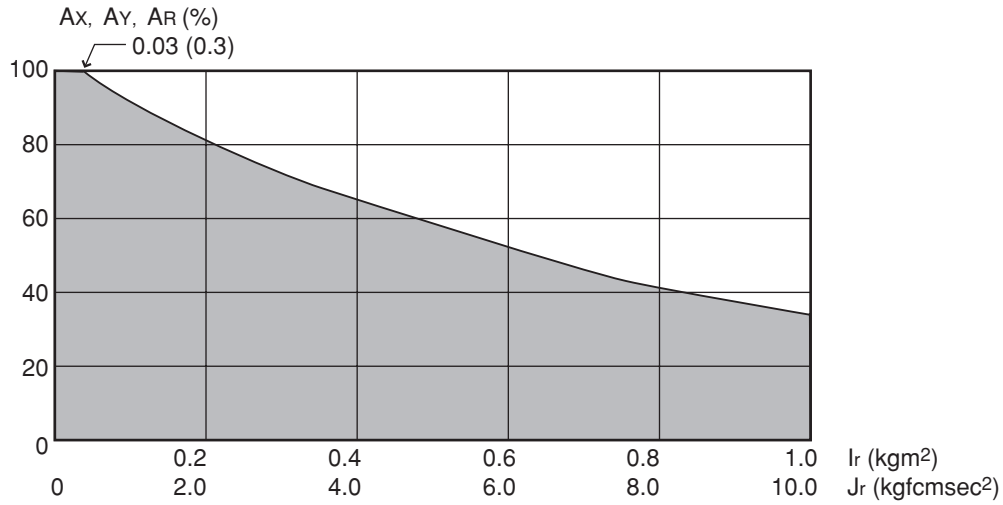


Fig. 3-11 m=1 to 20kg

6-1-4 Acceleration coefficient vs. moment of inertia (YK700XG, YK800XG)

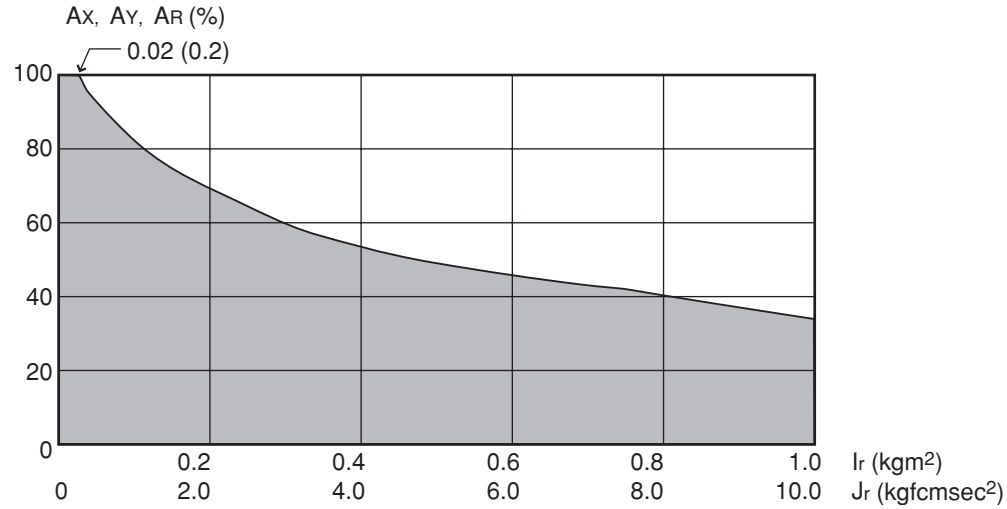


Fig. 3-12 m=1 to 20kg

6-1-5 Acceleration coefficient vs. moment of inertia (YK900XG, YK1000XG)

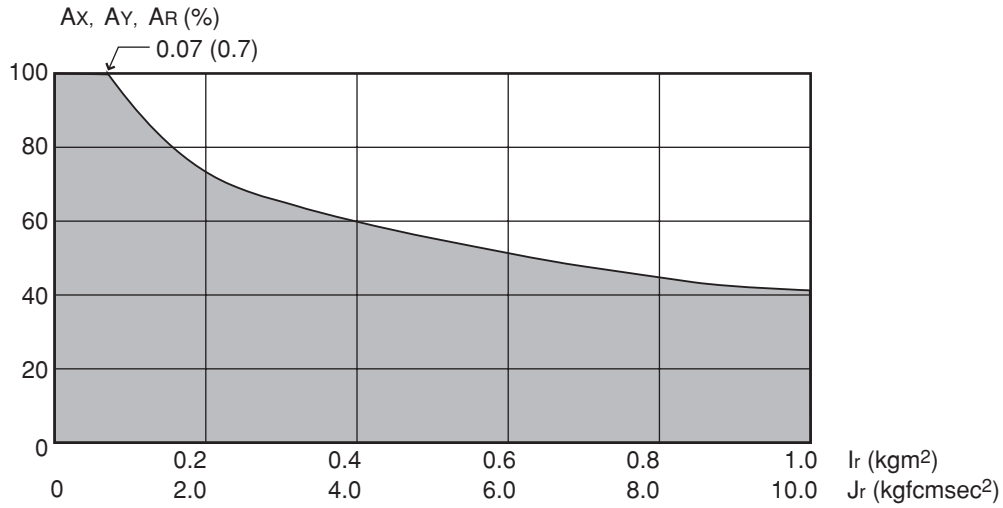


Fig. 3-13 m=1 to 20kg

6-2 Equation for moment of inertia calculation

Usually the R axis load is not a simple form, and the calculation of the moment of inertia is not easy. As a method, the load is replaced with several factors that resemble a simple form for which the moment of inertia can be calculated. The total of the moment of inertia for these factors is then obtained.
The objects and equations often used for the calculation of the moment of inertia are shown below. Incidentally, there is the following relation:
J (kgfcmsec^2) = I (kgm^2) × 10.2.

1) Moment of inertia for material particle
The equation for the moment of inertia for a material particle that has a rotation center such as shown in Fig. 3-14 is as follows:
This is used as an approximate equation when x is larger than the object size.

$$I = mx^2 \ (kgm^2)$$

$$J = \frac{Wx^2}{g} \ (kgfcmsec^2)$$

... (Eq. 3.1)

g : Gravitational acceleration (cm/sec^2)
m : Mass of material particle (kg)
W : Weight of material particle (kgf)

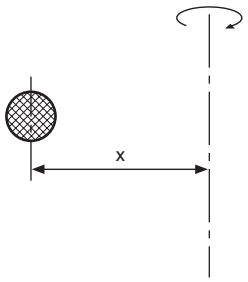


Fig. 3-14

2) Moment of inertia for cylinder (part 1)
The equation for the moment of inertia for a cylinder that has a rotation center such as shown in Fig. 3-15 is given below.

$$I = \frac{\rho\pi D^4 h}{32} = \frac{mD^2}{8} \ (kgm^2)$$

$$J = \frac{\rho\pi D^4 h}{32g} = \frac{WD^2}{8g} \ (kgfcmsec^2)$$

... (Eq. 3.2)

ρ : Density (kg/m^3, kg/cm^3)
g : Gravitational acceleration (cm/sec^2)
m : Mass of cylinder (kg)
W : Weight of cylinder (kgf)

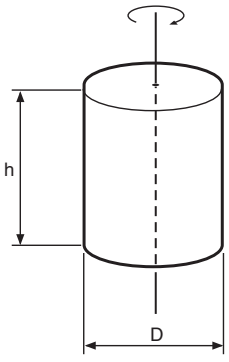


Fig. 3-15

3) Moment of inertia for cylinder (part 2)
The equation for the moment of inertia for a cylinder that has a rotation center such as shown in Fig. 3-16 is given below.

$$I = \frac{\rho\pi D^2 h}{16}\left(\frac{D^2}{4}+\frac{h^2}{3}\right) = \frac{m}{4}\left(\frac{D^2}{4}+\frac{h^2}{3}\right) \quad (kgm^2)$$

$$J = \frac{\rho\pi D^2 h}{16g}\left(\frac{D^2}{4}+\frac{h^2}{3}\right) = \frac{W}{4g}\left(\frac{D^2}{4}+\frac{h^2}{3}\right) \quad (kgfcmsec^2)$$

... (Eq. 3.3)

ρ : Density (kg/m^3, kg/cm^3)
g : Gravitational acceleration (cm/sec^2)
m : Mass of cylinder (kg)
W : Weight of cylinder (kgf)

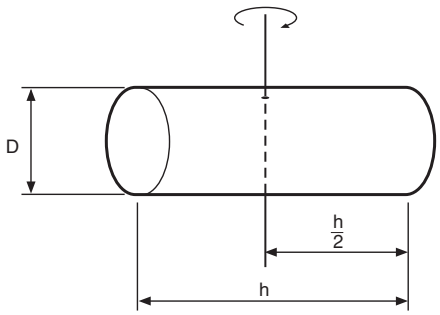


Fig. 3-16

4) Moment of inertia for prism
The equation for the moment of inertia for a prism that has a rotation center as shown in Fig. 3-17 is given as follows.

$$I = \frac{\rho\, abc(a^2+b^2)}{12} = \frac{m(a^2+b^2)}{12} \quad (kgm^2)$$

$$J = \frac{\rho\, abc(a^2+b^2)}{12g} = \frac{W(a^2+b^2)}{12g} \quad (kgfcmsec^2)$$

... (Eq. 3.4)

ρ : Density (kg/m^3, kg/cm^3)
g : Gravitational acceleration (cm/sec^2)
m : Mass of prism (kg)
W : Weight of prism (kgf)

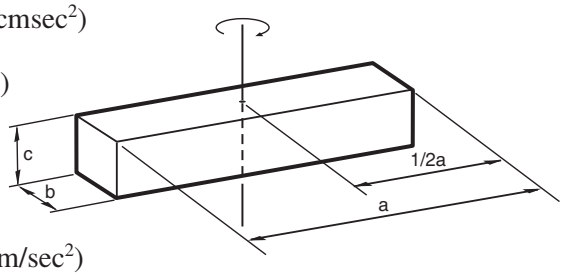


Fig. 3-17

5) When the object's center line is offset from the rotation center.
The equation for the moment of inertia, when the center of the cylinder is offset by the distance "x" from the rotation center as shown in Fig. 3-18, is given as follows.

$$I = \frac{\rho\pi D^4 h}{32} + \frac{\rho\pi D^2 h x^2}{4} = \frac{mD^2}{8} + mx^2 \quad (kgm^2)$$

$$J = \frac{\rho\pi D^4 h}{32g} + \frac{\rho\pi D^2 h x^2}{4g}$$

$$= \frac{WD^2}{8g} + \frac{Wx^2}{g} \quad (kgfcmsec^2)$$

... (Eq. 3.5)

ρ : Density (kg/m^3, kg/cm^3)
g : Gravitational acceleration (cm/sec^2)
m : Mass of cylinder (kg)
W : Weight of cylinder (kgf)

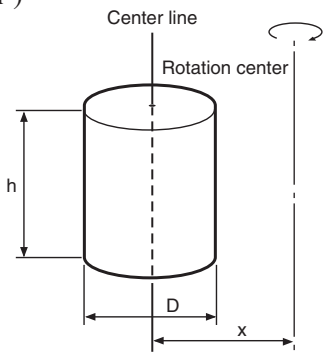


Fig. 3-18

In the same manner, the moment of inertia of a cylinder as shown in Fig. 3-19 is given by

$$I = \frac{\rho\pi\, D^2 h}{16}\left(\frac{D^2}{4} + \frac{h^2}{3}\right) + \frac{\rho\pi\, D^2 h\, x^2}{4} = \frac{m}{4}\left(\frac{D^2}{4} + \frac{h^2}{3}\right) + mx^2 \quad (kgm^2)$$

$$J = \frac{\rho\pi\, D^2 h}{16g}\left(\frac{D^2}{4} + \frac{h^2}{3}\right) + \frac{\rho\pi\, D^2 h\, x^2}{4g}$$

$$= \frac{W}{4g}\left(\frac{D^2}{4} + \frac{h^2}{3}\right) + \frac{Wx^2}{g} \quad (kgfcmsec^2)$$

... (Eq. 3.6)

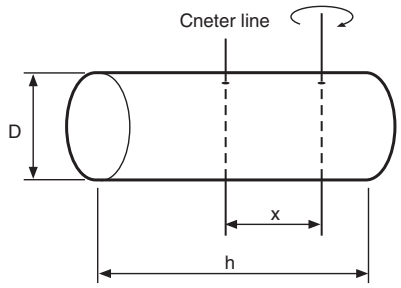


Fig. 3-19

In the same manner, the moment of inertia of a prism as shown in Fig. 3-20 is given by

$$I = \frac{\rho abc(a^2 + b^2)}{12} + \rho abcx^2 = \frac{m(a^2 + b^2)}{12} + mx^2 \quad (kgm^2)$$

$$J = \frac{\rho abc(a^2 + b^2)}{12g} + \frac{\rho abcx^2}{g}$$

$$= \frac{W(a^2 + b^2)}{12g} + \frac{Wx^2}{g} \quad (kgfcmsec^2)$$

... (Eq. 3.7)

m : Mass of prism (kg)
W : Weight of prism (kgf)

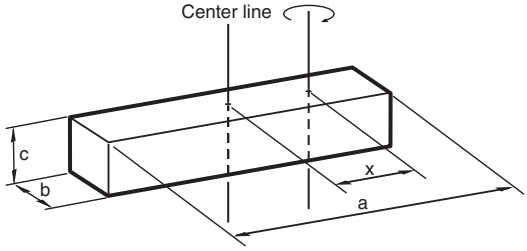


Fig. 3-20

6-3 Example of moment of inertia calculation

Let's discuss an example in which the chuck and workpiece are at a position offset by 10cm from the R-axis by a stay, as shown in Fig. 3-21. The moment of inertia is calculated with the following three factors, assuming that the load material is steel and its density ρ is 0.0078kg/cm^3.

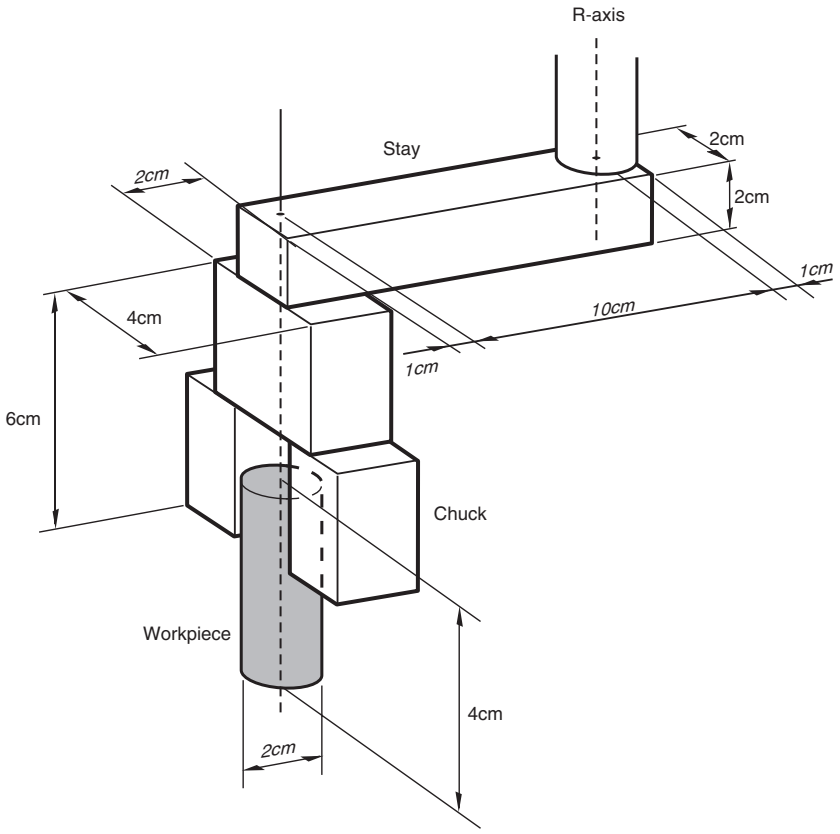


Fig. 3-21

1) Moment of inertia of the stay

From Fig. 3-22, the weight of the stay (Ws) is given as follows:

$Ws = \rho abc = 0.0078 \times 12 \times 2 \times 2$

$= 0.37$ (kgf)

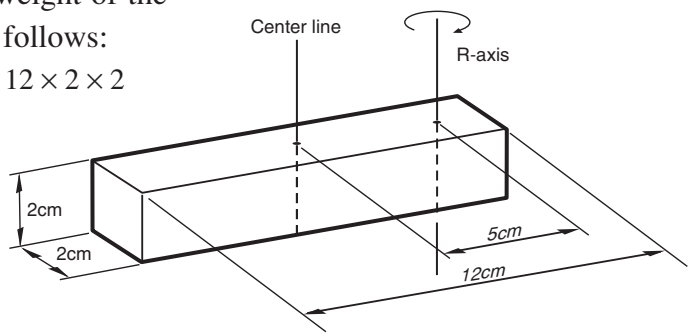


Fig. 3-22

The moment of inertia of the stay (Js) is then calculated from Eq. 3-7.

$$Js = \frac{0.37 \times (12^2+2^2)}{12 \times 980} + \frac{0.37 \times 5^2}{980} = 0.014 \text{ (kgfcmsec}^2\text{)}$$

2) Moment of inertia of the chuck

When the chuck form resembles that shown in Fig. 3-23, the weight of the chuck (Wc) is

$Wc = 0.0078 \times 2 \times 4 \times 6$

$= 0.37$ (kgf)

The moment of inertia of the chuck (Jc) is then calculated from Eq. 3-7.

$$Jc = \frac{0.37 \times (2^2+4^2)}{12 \times 980} + \frac{0.37 \times 10^2}{980}$$

$= 0.038$ (kgfcmsec^2)

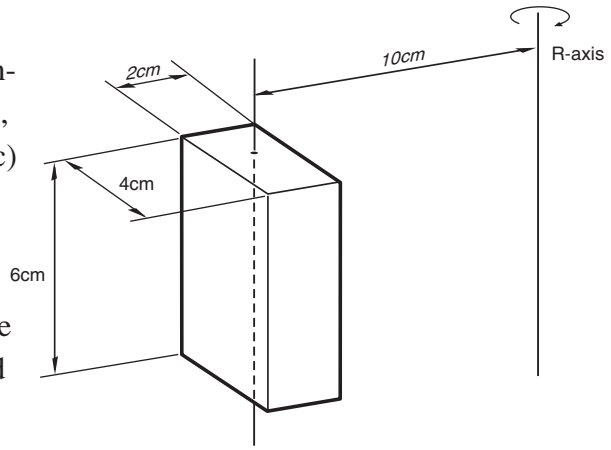


Fig. 3-23

3) Moment of inertia of workpiece

When the workpiece form resembles that shown in Fig. 3-24, the weight of the workpiece (Ww) is

$$Ww = \frac{\rho\pi D^2 h}{4} = \frac{0.0078\pi \times 2^2 \times 4}{4}$$

$= 0.098$ (kgf)

The moment of inertia of the workpiece (Jw) is then calculated from Eq. 3-5.

$$Jw = \frac{0.097 \times 2^2}{8 \times 980} + \frac{0.097 \times 10^2}{980}$$

$= 0.010$ (kgfcmsec^2)

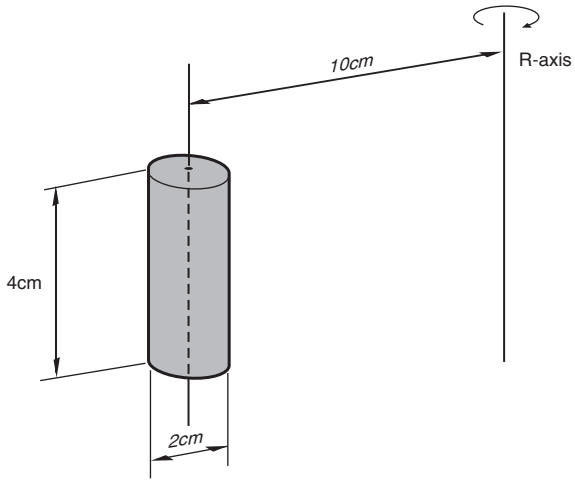


Fig. 3-24

4) Total weight

The total weight (W) is calculated as follows:

$W = Ws + Wc + Ww = 0.84$ (kgf)

5) Total moment of inertia

The total moment of inertia (J) is then obtained as follows:

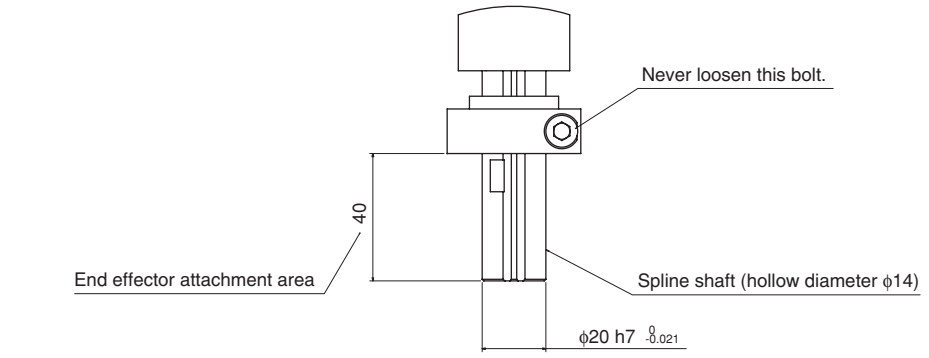
$J = Js + Jc + Jw = 0.062$ (kgfcmsec^2)

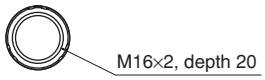
6-4 Attaching the end effector

⚠ WARNING

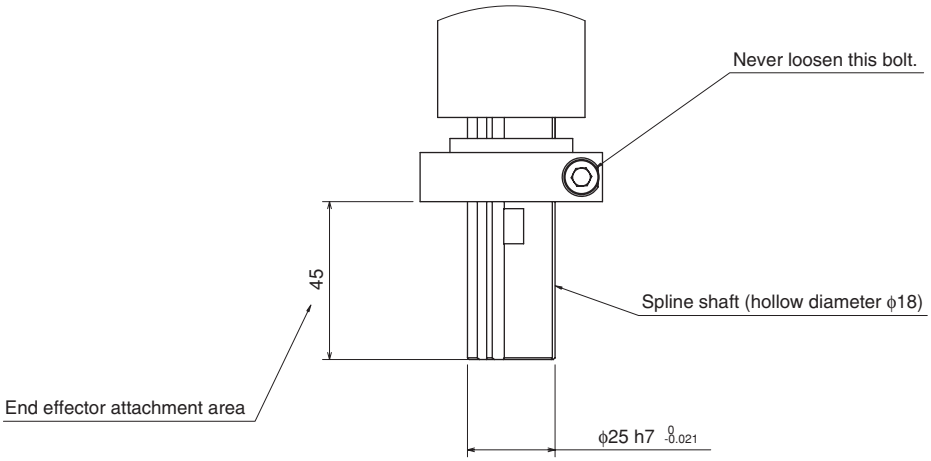
- Before attaching the end effector, be sure to turn off the controller.
- When the end effector is attached by slot clamping, always observe the conditions listed in Table 3-2. If these are ignored, the end effector may come loose and fly off during robot operation, resulting in an accident or injury.
- In cases where other attachment methods are used, be sure that the end effector will not come off when the loads listed in Table 3-1 are applied.

The user's end effector that attaches to the robot must have adequate strength and rigidity, as well as gripping force to prevent positioning errors. Table 3-1 shows the maximum load that can be applied to the end effector attachment of each robot model. Recommended methods for attaching end effectors are shown in Table 3-2 and Fig. 3-27. Refer to Fig. 3-25 for details on the end effector attachment of each robot model. Refer to Fig. 3-3 for the depth of tapped hole and recommended type of tap bolt. When checking end effector operation, refer to "6 Trial Operation" in Chapter 1.





YK500XG, YK600XG



YK600XGH, YK700XG, YK800XG, YK900XG, YK1000XG

Fig. 3-25

⚠ WARNING

- The tapped hole (see Figs. 3-25) provided on the lower part of the end effector attachment should be used only for preventing the end effector from coming loose.
- Do not fasten the end effector just by using this tapped hole. If the end effector is fastened only with this tapped hole, it may come loose from the attachment during robot operation and fly off resulting in accidents or injuries.

Table 3-1

Robot Model	F_{XY}max		$F_Z$max		$F_R$max		$M_R$max		Mmax	
	N	kgf	N	kgf	N	kgf	Nm	kgfm	Nm	kgfm
YK500XG	173	18	134	14	506	52	24	2.6	15	1.5
YK600XG	173	18	134	14	506	52	24	2.6	15	1.5
YK600XGH	489	49	214	22	696	71	56	5.7	26	2.7
YK700XG	489	49	214	22	696	71	56	5.7	26	2.7
YK800XG	489	49	191	19	696	71	56	5.7	24	2.4
YK900XG	443	46	191	19	696	71	56	5.7	24	2.4
YK1000XG	443	46	191	19	696	71	56	5.7	24	2.4

⚠ WARNING

- The end effector attachment must have adequate strength to withstand the loads listed in Table 3-1. If too weak, the attachment may break during robot operation and fragments fly off causing accidents or injuries.
- The end effector attachment must have sufficient rigidity versus the loads listed in Table 3-1. If this rigidity is inadequate, the end effector may vibrate during robot operation causing bad effects on the manipulator operation.

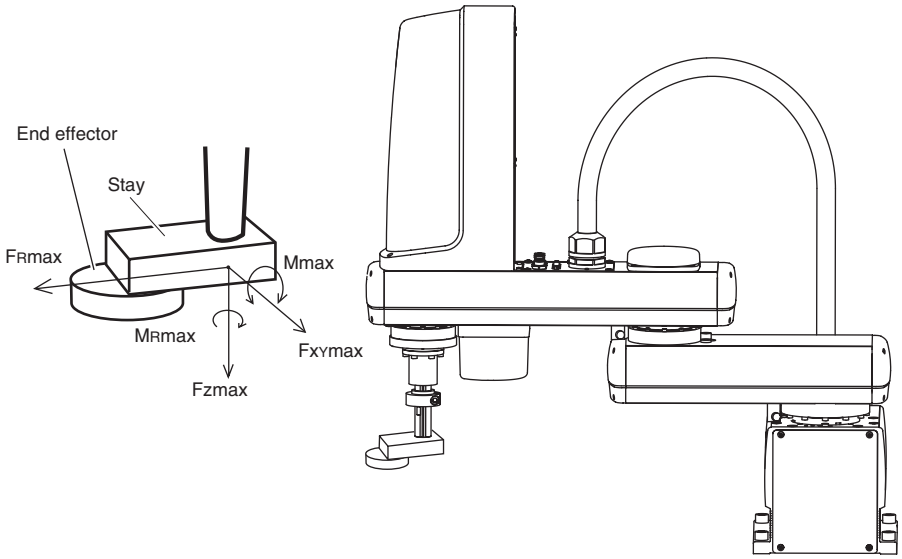


Fig. 3-26 Maximum load applied to end effector attachment

Table 3-2

Robot Model	Bolts Used	Number of bolts	Tightening torque		Hole diameter (mm)
			Nm	kgfcm	
YK500XG, YK600XG	M6 or lager	2 or more	15.3	156	$20\ ^{+0.021}_{0}$
YK600XGH, YK700XG, YK800XG, YK900XG, YK1000XG	M8 or lager	2 or more	37.0	380	$25\ ^{+0.021}_{0}$

Table 3-3

Depth of tapped hole	Iron material base	Bolt diameter × 1.5 or more
	Aluminum material base	Bolt diameter × 3.0 or more
Recommended bolt	JIS B 1176 hex socket head bolt, or equivalent (Strength class: JIS B 1051 12.9, or equivalent)	

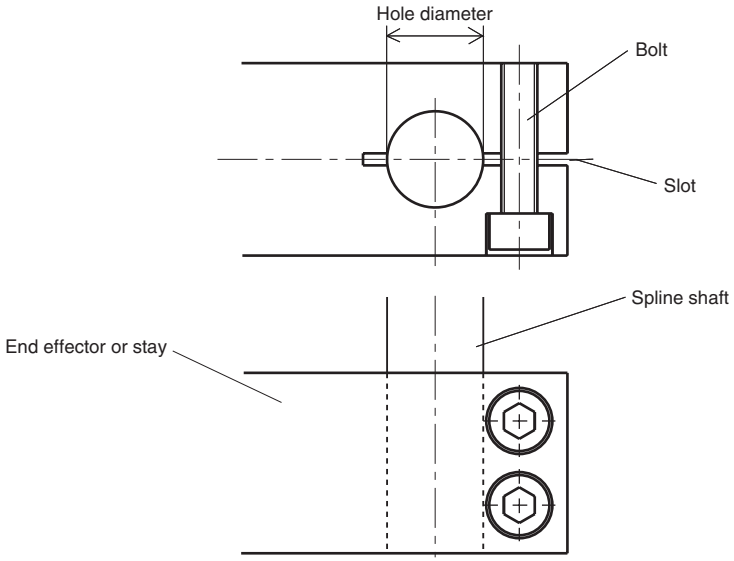


Fig. 3-27

6-5 Gripping force of end effector

The gripping force of the end effector must have a sufficient extra margin of strength versus the workpiece weight and reaction force applied to the workpiece during robot operation. The reaction force applied to the workpiece during operation can be calculated from the acceleration applied to the end effector attachment. The maximum acceleration on the end effector attachment of each robot model is listed in the table below. When the workpiece position is offset to the end effector attachment, the accelerations Amax and A_{XY}max become larger by an amount equal to the offset versus the arm length. When the R-axis rotates during operation, this acceleration $A_R$max must be taken into account.

Table 3-4 Maximum acceleration during robot operation

Robot Model	Amax(m/sec²)	A_{XY}max(m/sec²)	Azmax(m/sec²)	$A_R$max(rad/sec²)
YK500XG	98	48	57	280
YK600XG	104	41	57	280
YK600XGH	78	60	38	176
YK700XG	96	60	38	176
YK800XG	101	51	38	176
YK900XG	95	51	38	176
YK1000XG	95	51	38	176

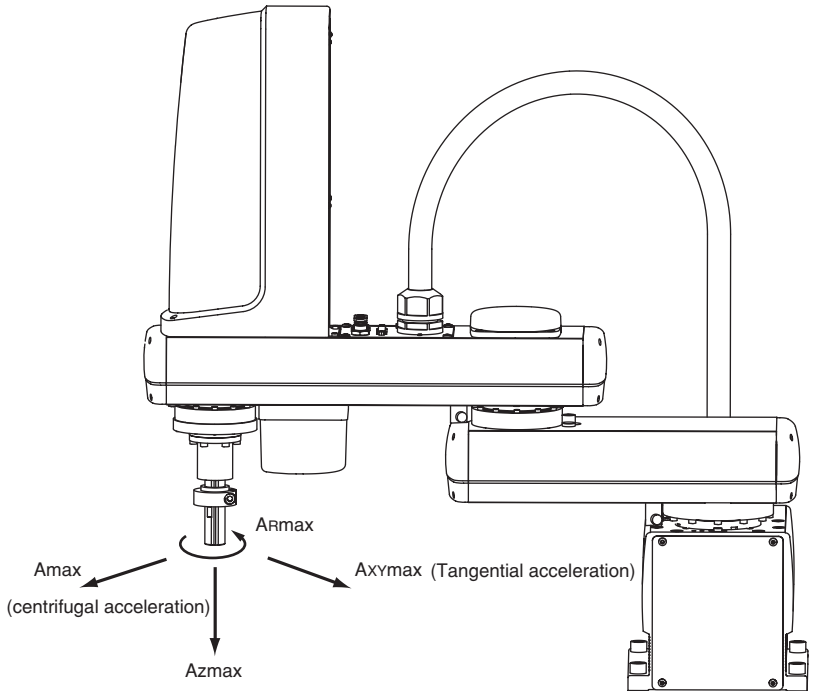


Fig. 3-28 Maximum acceleration on end effector attachment

⚠ WARNING

The gripping force of the end effector must have a sufficient extra margin of strength to prevent the workpiece from coming loose and flying off during robot operation. If the gripping force is too weak, the workpiece may come loose and fly off causing accidents or injuries.

7 Limiting the Movement Range with X-Axis Mechanical Stoppers

In the YK-XG Series, the movement range can be limited by changing the X-axis mechanical stopper positions. (See Fig. 3-29.) The Y-axis mechanical stopper positions are fixed and cannot be changed. When the robot is shipped from the factory, the movement range is set to the maximum. If the maximum movement range is too large compared to the actual work range, or the manipulator might interfere with peripheral units, then the movement range can be limited as outlined below. The X-axis mechanical stopper positions may slightly differ depending on machining precision.

⚠WARNING

Always turn off the controller before changing the movement range with mechanical stoppers.

⚠CAUTION

When the mechanical stoppers are installed, the soft limits must be set to a point inside the mechanical stopper positions. (Refer to "4 Setting the Soft Limits" in Chapter 4.)

7-1 YK500XG, YK600XG, YK600XGH, YK700XG, YK800XG, YK900XG, YK1000XG

To change the X-axis mechanical stopper positions, for example, from the maximum movement range (132°) to 87°, use the following procedure.

1) Prepare a hex wrench set.

2) Turn off the robot controller.

3) Place a sign indicating the robot is being adjusted, to keep others from touching the controller switch.

4) Enter the safeguard enclosure.

5) Remove the screw plug, X-axis mechanical stopper bolt and washer as shown in Fig. 3-30. Then reinstall the mechanical stopper bolt and washer at the position that determines the desired movement range by tightening the bolt to the torque specified in Table 3-5.
Reinstall the screw plug you removed, into the position where the X-axis stopper bolt was installed.

6) Check that the movement range is limited by the mechanical stoppers as desired.

7) Go outside the safeguard enclosure.

8) Check that no one is inside the safeguard enclosure when turning on the controller.

Table 3-5

Robot Model	Bolt size	Tightening torque (kgfcm)	Tightening torque (Nm)
YK500XG,YK600XG	M8	380	37.2
YK600XGH, YK700XG, YK800XG, YK900XG, YK1000XG	M10	459	45.0

Use only YAMAHA genuine bolts or JIS B 1176 hex socket head bolts (strength class: JIS B 1051 12.9).

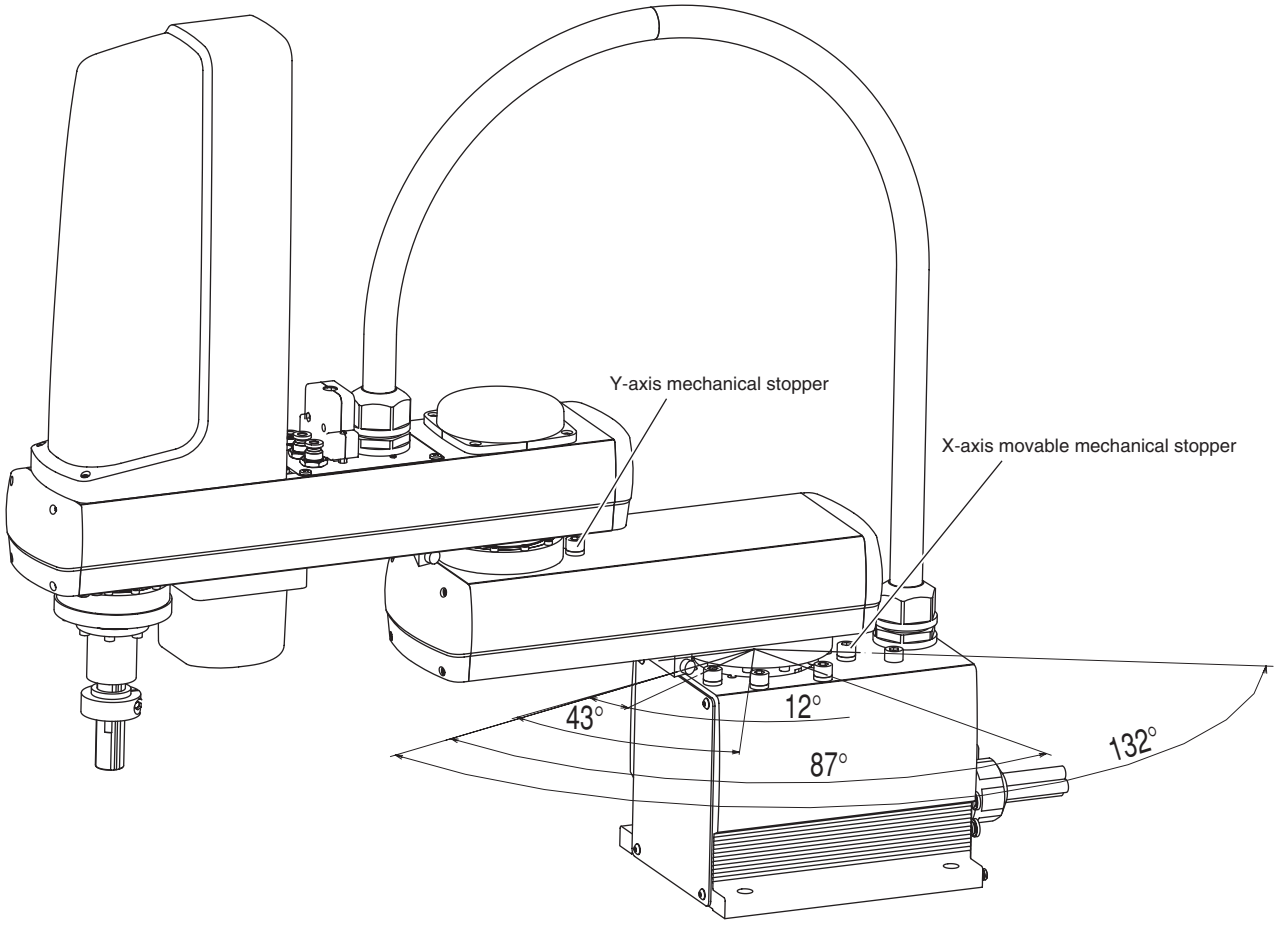


Fig. 3-29 X-axis movable mechanical stopper position

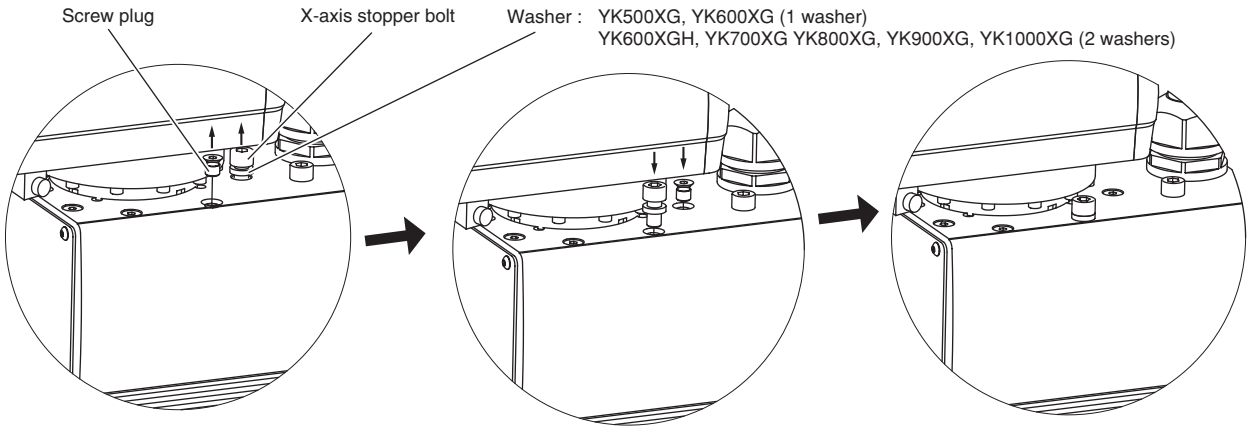


Fig. 3-30 Changing the X-axis mechanical stopper position

8 Working Envelope and Mechanical Stopper Positions for Maximum Working Envelope

Working envelope of each robot and mechanical stopper positions for the maximum working envelope are shown in "1-2 External view and dimensions" in Chapter 7.
Here, those are described using the YK500XG as an example. Other robot models are the same.

1) X and Y axes
   1. Do not attempt operation outside the working envelope. On the YK-XG series, the origin can be set at a discrete position. The working envelope described in this manual is an area with the robot frontal reference when no load is applied.
   2. Interference positions where a load may touch the robot within the working envelope and their radii are shown in the figure. Here, "a", "b", "c" and "d" are the respective interference positions with the base front panel, base side panel, base rear panel, and base corners. Be careful not to allow the robot load to interfere with any part of the robot.
      The Z-axis spline may touch the base or the Y-axis arm may touch the wire harness before the robot strikes the X-axis or Y-axis mechanical stoppers, so use caution.
   3. Interference positions where a load might touch the robot within the maximum movement range and their radii are shown in the figure. Here, "a", "b", "c" and "d" are the respective interference positions with the base front panel, base side panel, base rear panel and the base corners. The Z-axis spline may touch the base or the Y-axis arm may touch the wire harness before the robot strikes the X-axis or Y-axis mechanical stoppers, so use caution.

2) Z-axis
   Do not attempt work outside the working envelope. In particular, do not attempt work in the area between the working envelope and mechanical stopper position. Mechanical stoppers are installed at both the upper and lower ends of the movement range.

⚠WARNING

The robot cable, user wiring or tubing may be damaged if the robot load interferes with them resulting in hazardous robot malfunctions. Do not operate at points where the load may interfere with the robot cable, user wiring or tubing.

3) R-axis
   The R-axis has no mechanical stoppers.

⚠CAUTION

Since the R-axis has no mechanical stoppers, make certain that the end effector wiring and tubing do not become entangled during operation.

4) Robot overrun during impacts with mechanical stopper
A urethane damper is installed to absorb the shock when an impact occurs with the mechanical stopper, so a certain amount of overrun occurs when the robot strikes the mechanical stopper. Use caution and take overrun into account since the end effector may interfere with the robot body and peripheral equipment or the robot body may interfere with the peripheral equipment. Maximum overrun amounts are listed below (for normal operation, maximum payload, maximum speed).

Robot model	X-axis	Y-axis	Z-axis	
			Upper end	Lower end
YK500XG,YK600XG	9°	12°	5mm	5mm
YK600XGH, YK700XG to YK800XG	9°	12°	5mm	5mm

Note: Here, ° (deg.) is the overrun angle at the X-axis and Y-axis joints.

(1) If the X-axis, Y-axis or Z-axis mechanical stopper is deformed or damaged by impacts, please contact our sales office or dealer. Using the deformed or damaged mechanical stopper is dangerous, so it must be replaced.
(2) When the robot strikes the X-axis or Y-axis mechanical stopper or another object, or when the R-axis collides with an object, speed reduction gears are locked while being meshed if the collision impact is large. If this happens, please contact our sales office or dealer.

CHAPTER 4

Adjustment

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MEMO

1 Overview

YAMAHA robots have been completely adjusted at the factory or by the sales representative before shipment, including the origin position adjustment. If the operating conditions are changed and the robot must be adjusted, then follow the procedures described in this chapter.

2 Safety Precautions

(1) Read and understand the contents of this chapter completely before attempting to adjust the robot.

(2) Place a conspicuous sign indicating the robot is being adjusted, to prevent others from touching the controller switch, programming unit or operation panel.

(3) If a safeguard enclosure has not yet been provided right after installation of the robot, rope off or chain off the movement area around the manipulator in place of a safeguard enclosure, and observe the following points.
①Use stable posts which will not fall over easily.
②The rope or chain should be easily visible by everyone around the robot.
③Place a conspicuous sign prohibiting the operator or other personnel from entering the movement area of the manipulator.

(4) To check operation after adjustment, refer to "6. Trial Operation" in Chapter 1.

3 Adjusting the Origin

All models of the YK-XG series robots use an absolute type position detector. The origin position (zero pulse point) can be determined by absolute reset. Once absolute reset is performed, you do not have to repeat absolute reset when turning the power on next time. However, absolute reset is required if any of the following cases occur. The robot is shipped from the factory in condition "c" (below), so please perform absolute reset after installing the robot. For more details on absolute reset, refer to "Absolute Reset" in Chapter 4 of the "YAMAHA Robot Controller User's Manual".

a. Absolute-related error occurred on the axis.
b. Power drop was detected in the absolute battery for the driver installed inside the robot controller.
c. Cable connecting the robot unit to the controller was disconnected. (This is the status when shipped from the factory.)
d. Robot generation was changed.
e. Parameters were initialized.
f. Axis parameters "Origin shift", "Origin method", "Origin direction" or "Motor direction" were changed.
g. Motor was replaced. (Motor wiring connector was removed.)
h. Data in the ALL data file (extension: ALL) or parameter file (extension: PRM) was written into the controller by way of the RS-232C.

The following sections explain how to perform absolute reset.

⚠CAUTION

- If any of the above cases occur after installing the robot, absolute reset must be performed again. To perform absolute reset, move the robot arms back to their origin positions where the robot does not interfere with peripheral equipment after the setup is complete.
- After performing absolute reset, move the robot to a known point to check whether the origin position is correctly set. When doing this check, move the robot at the slowest possible speed.
- The standard coordinate and point data must be reset when the origin position is changed.
- Make point data setting after changing the origin position. After changing the origin position, do not use the previous point data.

There are three absolute reset methods for the YK-XG series: the sensor method, mark method, and stroke end method. The X-axis, Y-axis, and R-axis use the sensor method as the initial setting, while the Z-axis uses the stroke end method.

3-1 Absolute reset method

3-1-1 Sensor method (X-axis, Y-axis, and R-axis)

In the sensor method, the target axis is automatically operated for the absolute reset, and the absolute reset is performed at the position where the proximity sensor provided on the target axis detects the detection area (dog). The absolute reset in the sensor method can be executed with the teaching pendant (MPB), RS-232C communication, and dedicated input.

⚠ WARNING

Serious injury might occur from physical contact with the robot during operation. Never enter within the robot movement range during absolute reset.

⚠ CAUTION

The origin cannot be detected in any axis which is not positioned on the plus side from the origin (see Fig. 4-2) before starting the return-to-origin operation. (Factory setting at shipment.) In this case, press the STOP key to interrupt the return-to-origin operation, move the target axis to the plus side of the origin, and reperform the origin return operation. If the return-to-origin operation is not interrupted, the robot will continue the operation and may collide with the mechanical stopper or a peripheral device. Since a mechanical stopper is not provided in the R-axis, the wiring and piping installed on the end effecter may be wound up by the operation.

3-1-2 Stroke end method (Z-axis)

In the stroke end method, absolute reset is performed at a position slightly backed off from the stroke end, after the Z-axis contacts the mechanical stopper and stroke end is detected.

⚠ WARNING

Serious injury might occur from physical contact with the robot during operation. Never enter within the robot movement range during absolute reset.

3-2 Machine reference

The YK-XG series position detectors are resolvers that have four positions where absolute reset can be performed per motor revolution. If the sensor method is used for the absolute reset, the origin position will be set at the positions where absolute reset can be performed soon after the origin sensor reacts to the dog (the origin signal is detected). The machine reference means the position relationship of the position where the robot detects the origin signal to the position where the absolute reset can be performed soon after detection (see Fig. 4-1). The machine reference is expressed with the ratio of interval A to interval B shown in Fig. 4-1. Interval A is the minimum distance between the positions where absolute reset can be performed and interval B is the distance between the position where the origin signal is detected and the position where absolute reset can be performed soon after the origin signal detection. The machine reference value (unit: %) is displayed on the optional MPB screen.

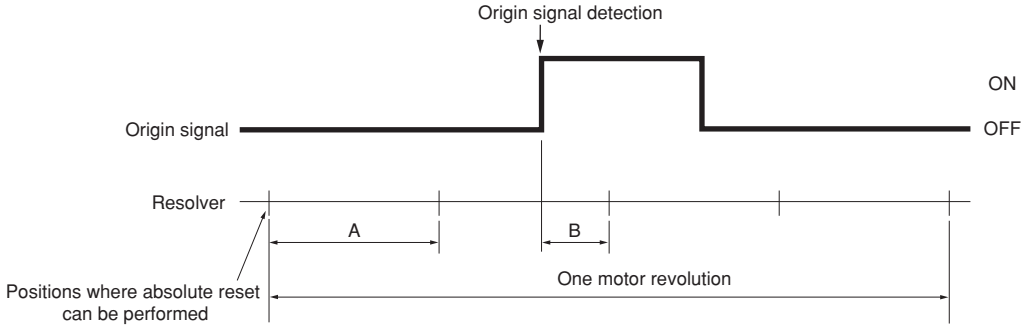
Machine reference value = B/A × 100(%)

⚠CAUTION

The machine reference must be adjusted within a specified range to keep the repeatability precision of the absolute reset position (The machine reference is factory-adjusted prior to shipping). If the origin position is changed, the machine reference must be readjusted. For information on how to adjust the machine reference, refer to "3-4 Changing the origin position and adjusting the machine reference" in Chapter 4. When the temperature of the robot joint sections is high immediately after the robot has been operated, the machine reference value might be outside the specified range (40 to 60%). When checking or adjusting the machine reference value, always make sure that the temperature of the robot joint sections has returned to room temperature.

Recommended machine reference value: 40 to 60%

Machine reference



Machine reference display on MPB screen

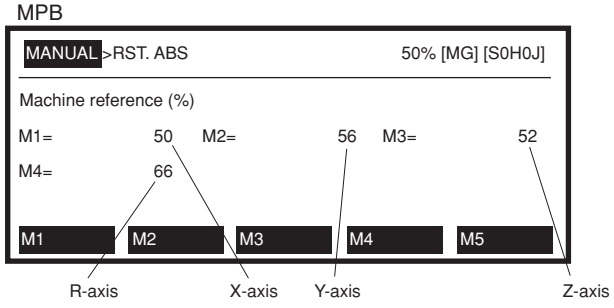


Fig. 4-1

3-3 Absolute reset procedures

3-3-1 Sensor method (X-axis, Y-axis, and R-axis)

⚠ WARNING

Serious injury might occur from physical contact with the robot during operation. Never enter within the robot movement range during absolute reset.

The operation procedure using the MPB is described next. (Press the ESC key on the MPB if you want to return to the preceding step.) See the "YAMAHA Robot Controller User's Manual" for information on operating the robot controller.

1) Check that no one is inside the safeguard enclosure and then turn on the controller.

2) Place a sign indicating the robot is being adjusted, to keep others from touching the controller switch or operation panel.

3) Set the controller to MANUAL mode, if not in MANUAL mode.

4) Press the F13 (LOWER+F3) key to select "RST. ABS".

5) Select the axis for absolute reset. (X-axis: M1, Y-axis: M2, R-axis: M4)
To perform absolute reset on all axes, select "ALL" with the F11 (LOWER+F1) key.

⚠ CAUTION

The Z-axis of the stroke end method first rises during the absolute reset of all axes (default setting). Be careful that your fingers do not get pinched or crushed by any sudden movement.

6) Check that the absolute reset axis must be positioned at the plus side of the origin. (See Fig. 4-2.) If it is not at the plus side, then press the jog key to move the target axis to the plus side.

7) Since the message "Reset ABS encoder OK?" is displayed, check that there are not any obstacles in the robot movement range, and press the F4 key (YES).

8) After the absolute reset is completed, check that the machine reference value displayed on the MPB is between 40 and 60 (recommended range). If the machine reference value is outside the recommended range, then the next absolute reset may not be properly performed. In this case, refer to "3-4 Changing the origin position and adjusting the machine reference", and make the necessary adjustments.

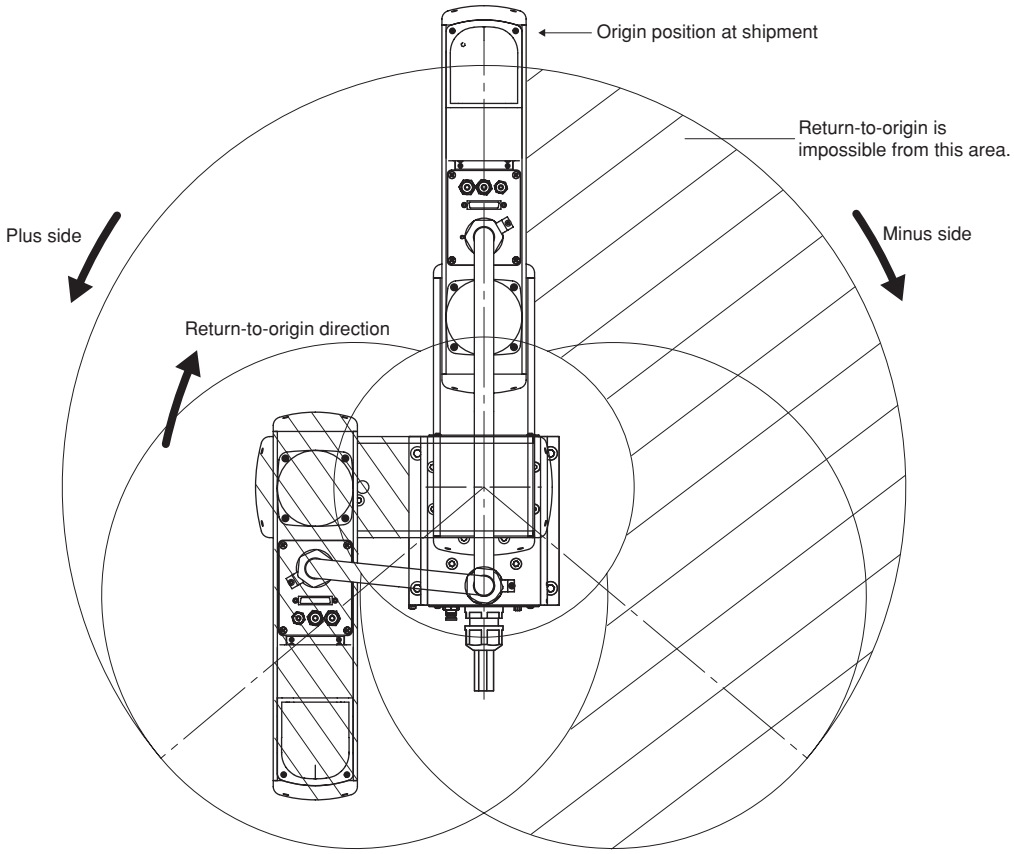


Fig. 4-2

3-3-2 Stroke end method (Z-axis)

⚠ WARNING

Serious injury might occur from physical contact with the robot during opera-tion. Never enter within the robot movement range during absolute reset.

The operation procedure using the MPB is described next. (Press the ESC key on the MPB if you want to return to the preceding step.) See the "YAMAHA Robot Controller User's Manual" for information on operat-ing the robot controller.

1) Check that no one is inside the safeguard enclosure and then turn on the controller.

2) Place a sign indicating the robot is being adjusted, to keep others from touching the controller switch or operation panel.

3) Set the controller to MANUAL mode, if not in MANUAL mode.

4) Press the F13 (LOWER+F3) key to select "RST. ABS".

5) Select M3 (Z-axis).

6) Since the message "Reset ABS encoder OK?" is displayed, check that there are not any obstacles in the robot movement range, and press the F4 key (YES).

7) After absolute reset is complete, check that the adjustment machine reference value displayed on the MPB is within the absolute reset tolerance range (33 to 67).

⚠ CAUTION

Use the following procedure to display the **adjustment machine reference value**. When **adjusting the machine reference value**, always check the **adjustment machine reference value** with this procedure.

(1) Press the MODE key.
(2) Press the F3 key to enter MANUAL mode.
(3) Press the F13 key (LOWER+F3) to select "ABS Reset".
(4) After the Z-axis absolute reset is complete, press the F10 (UPPER+F5) key to display the **adjustment machine reference value (%)**.

If the machine reference value is outside the absolute reset tolerance range, then the next absolute reset may not be properly performed. In this case, make the necessary adjustments by referring to "3-4 Changing the origin position and adjusting the machine reference" in Chapter 4.

3-4 Changing the origin position and adjusting the machine reference

⚠CAUTION

- If the origin position has been changed, then the absolute reset must be performed, the machine reference must be adjusted, and the standard coordinate and point data must be reset.
- If any machine reference is adjusted, the origin position may change. Before the adjustment, mark off the reference mark at the current origin position on the main body of the robot. After the machine reference is adjusted, be sure to check that the origin position has not deviated. If the origin position changes after the machine reference has been adjusted, then the standard coordinate and point data must be reset.

3-4-1 Sensor method

3-4-1-1 YK500XG, YK600XG, YK600XGH, YK700XG, YK800XG, YK900XG, YK1000XG

1-1 Adjusting the X-axis machine reference

⚠CAUTION

The origin position may change due to machine reference adjustment. If it occurs, you must set point data again.

The adjustment method for the X-axis machine reference is as follows.

1) Prepare a hex wrench set.

2) Check that no one is inside the safeguard enclosure and then turn on the controller.

3) Perform the absolute reset from outside the safeguard enclosure.
Refer to "3-3 Absolute reset procedures" for information about the absolute reset method.

4) If any machine reference value displayed on the MPB is not in the range between 40 and 60 (recommended range) after the absolute reset has been completed, then proceed with the following adjustment procedure.

5) Place a sign indicating that the robot is being adjusted in order to keep others from operating the controller or operation panel.

6) Turn off the controller and enter the safeguard enclosure.

7) Mark off the reference mark at the current origin position on the X-axis joint area of the robot.
At this time, be careful to prevent the origin position from deviating since the X-axis arm is touched.

8) Remove the cover.

9) Scribe a mark on the position of the X-axis origin sensor stay.

10) Using the hex wrench, loosen the two bolts securing the X-axis origin sensor stay. (See Fig. 4-3.)

⚠CAUTION

The bolts only need to be loosened, and do not need to be completely removed.

11) Move the X-axis origin sensor stay in the following manner and then secure it with the bolts.

NOTE

- When the machine reference is less than 40%, move the stay in direction ①: See Fig. 4-3 (b).
- When the machine reference is more than 40%, move the stay in direction ②: See Fig. 4-3(b).

As an approximate guide, a 1mm movement equals to 100%.

12) Go out of the safeguard enclosure, and check that no one is inside the safeguard enclosure. Then turn on the controller.

13) Perform the absolute reset from outside the safeguard enclosure.

14) After the absolute reset is completed, read the machine reference value displayed on the MPB.

15) If the machine reference value is in the range between 40 and 60 (recommended range), then the machine reference has been completely adjusted. If it is outside the recommended range, then repeat the procedure that starts in 5) to readjust it.

16) Reattach the cover after the adjustment is complete.

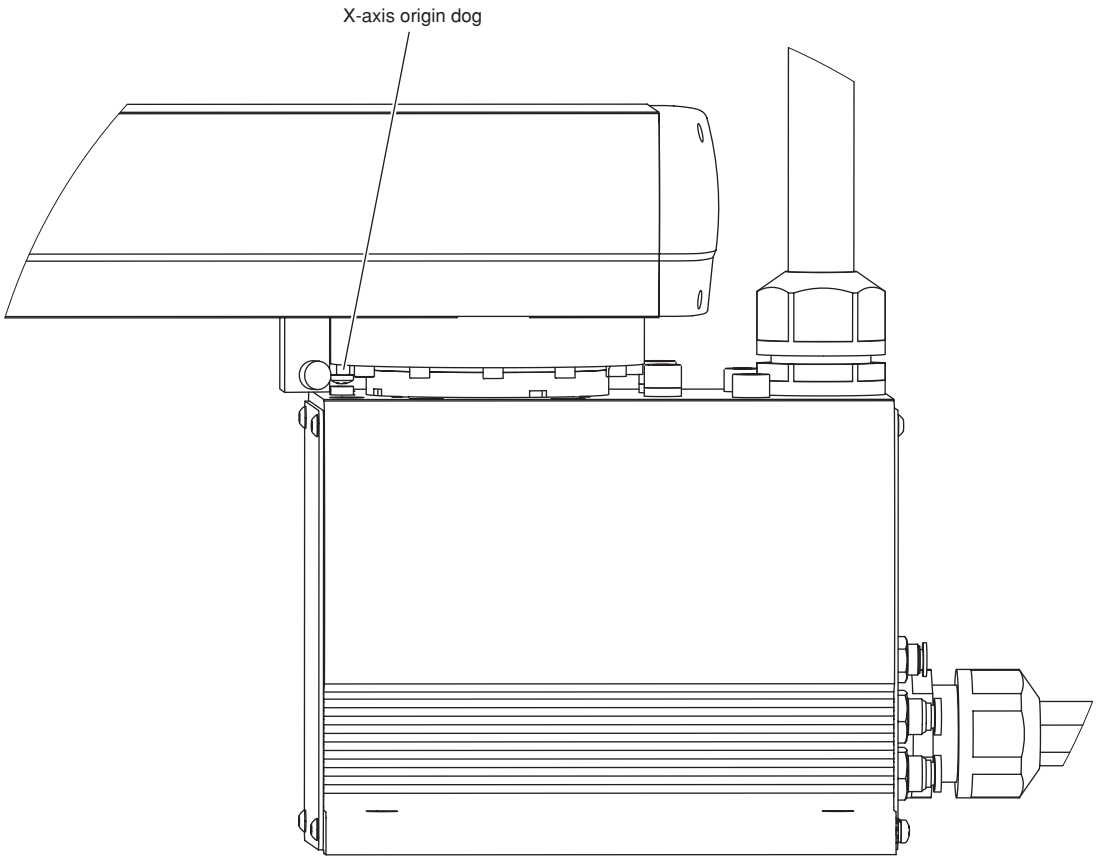


Fig. 4-3 (a)

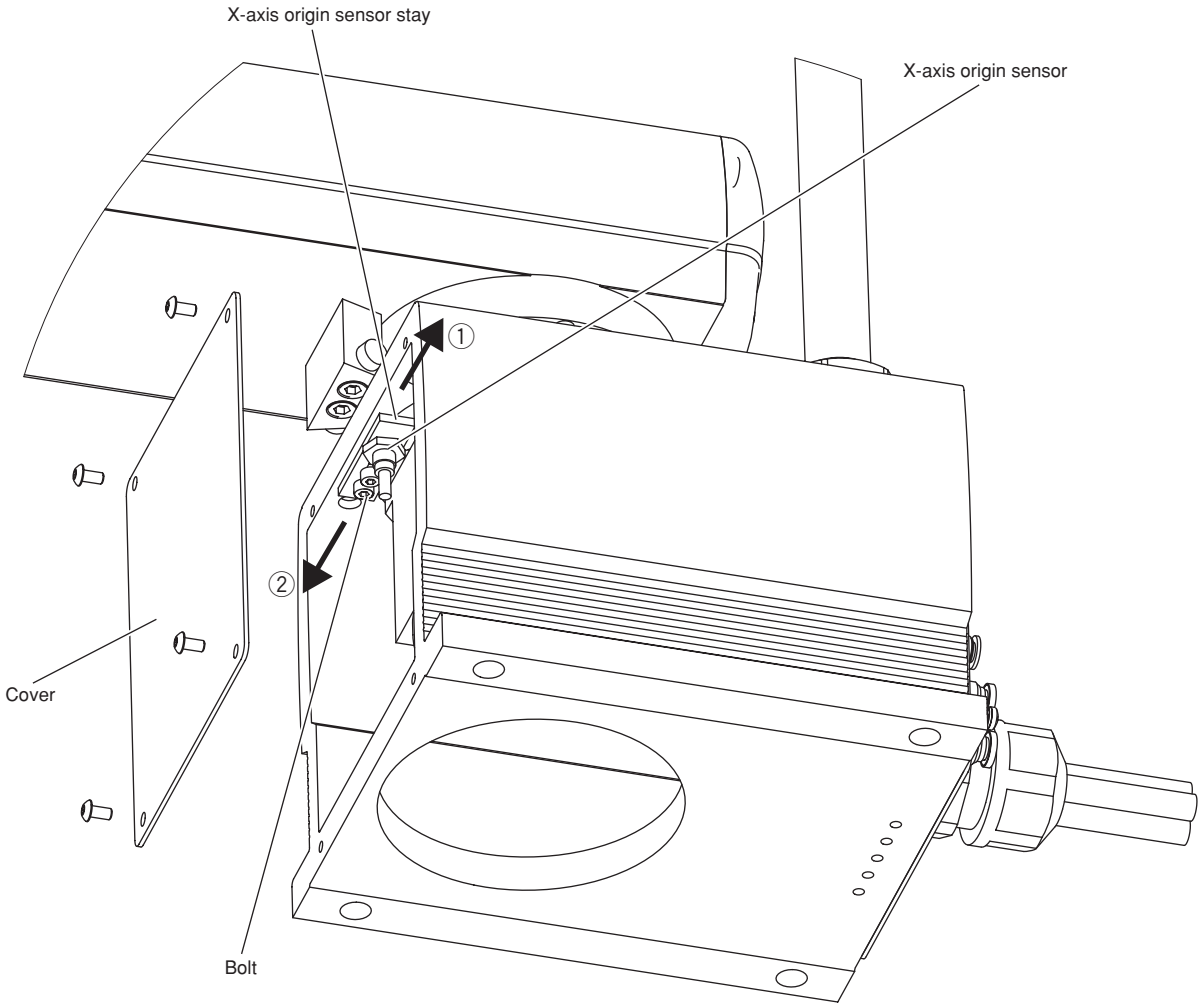


Fig. 4-3 (b)

1-2 Changing the X-axis origin position

The X-axis origin position can be changed to any position in the range from the front position of the X-axis arm base to a maximum of 120° clockwise and counterclockwise at 30° intervals, by changing the positions of the dog and the mounting bolt for the X-axis speed reduction unit as shown in Fig. 4-4.

⚠CAUTION

- If the origin position has been changed, then the absolute reset must be performed, the machine reference must be adjusted, and the standard coordinate and point data must be reset.
- The dog and bolt might come off and cause the joint to lock up unless you apply "Screw Lock" to them and tighten to the specified torque.

The following describes the method for changing the X-axis origin position, for example, to a position 90° counterclockwise.

1) Prepare the necessary tools.
   - Hex wrench set
   - Phillips screwdriver
   - Phillips screwdriver bit
   - Torque wrench
   - Screw Lock (thread sealant)
   - Hex bit
2) Check that no one is inside the safeguard enclosure and then turn on the controller.
3) Perform the absolute reset from outside the safeguard enclosure.
   Refer to "3-3 Absolute reset procedures" for information about the absolute reset method.
4) Place a sign indicating that the robot is being adjusted in order to keep others from operating the controller or operation panel.
5) Turn off the controller and enter the safeguard enclosure.
6) Remove the cover. (See Fig. 4-5 (a).)
7) Using the hex wrench, loosen the two bolts securing the X-axis origin sensor stay.
8) Remove the X-axis origin sensor stay.
9) Remove the dog and hex nut through the elongated hole.
   We recommend using the Phillips screwdriver bit and wrench to remove the dog since it is secured with "Screw Lock".
10) Rotate the X-axis arm 90° counterclockwise. (See Fig. 4-5 (b).)
11) Remove the bolt located opposite the elongated hole.
12) Apply "Screw Lock" to the dog and nut, insert them into the tapped hole where the bolt was attached, and tighten to the specified torque. (See Fig. 4-5 (c).)
13) Return the X-axis arm to the current origin position. (See Fig. 4-5 (d).)
14) Apply "Screw Lock" to the bolt, insert it into the tapped hole where the dog was attached, and tighten to the specified torque.

15) Temporarily fasten the X-axis origin sensor stay using the bolts. At this point, check that the sensor does not interfere with other parts while turning the X-axis arm by hand.

16) Go out of the safeguard enclosure, and check that no one is inside the safeguard enclosure. Then turn on the controller.

17) Perform the absolute reset from outside the safeguard enclosure.

18) After the absolute reset is completed, read the machine reference value displayed on the MPB.

19) If the machine reference value is in the range between 40 and 60 (recommended range), then the origin position has been correctly changed. Fully tighten the bolts to secure the X-axis origin sensor stay. If it is outside the recommended value, then adjust the machine reference by referring to "1-1 Adjusting the X-axis machine reference".

20) Reattach the cover after the adjustment is complete.

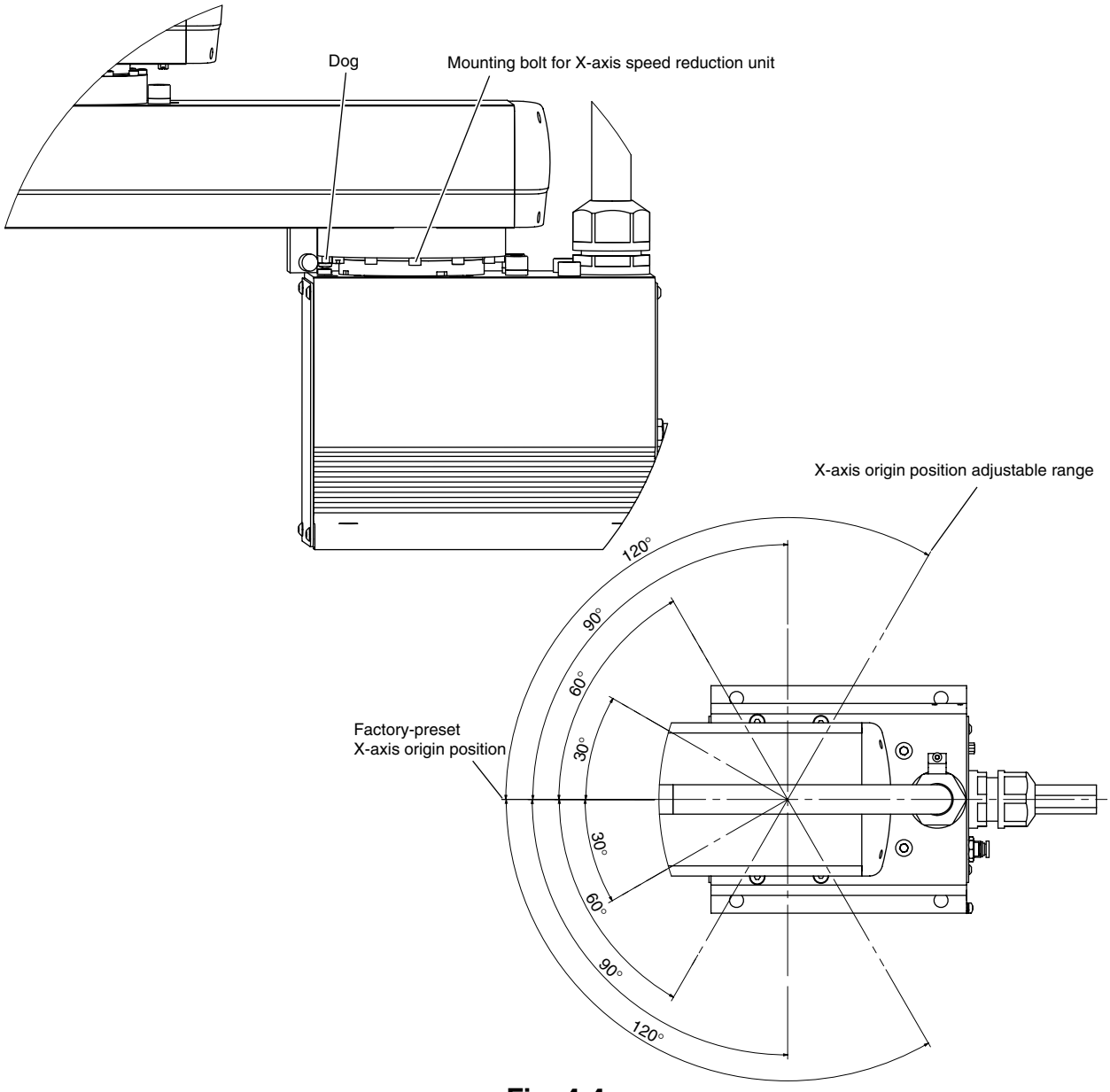


Fig. 4-4

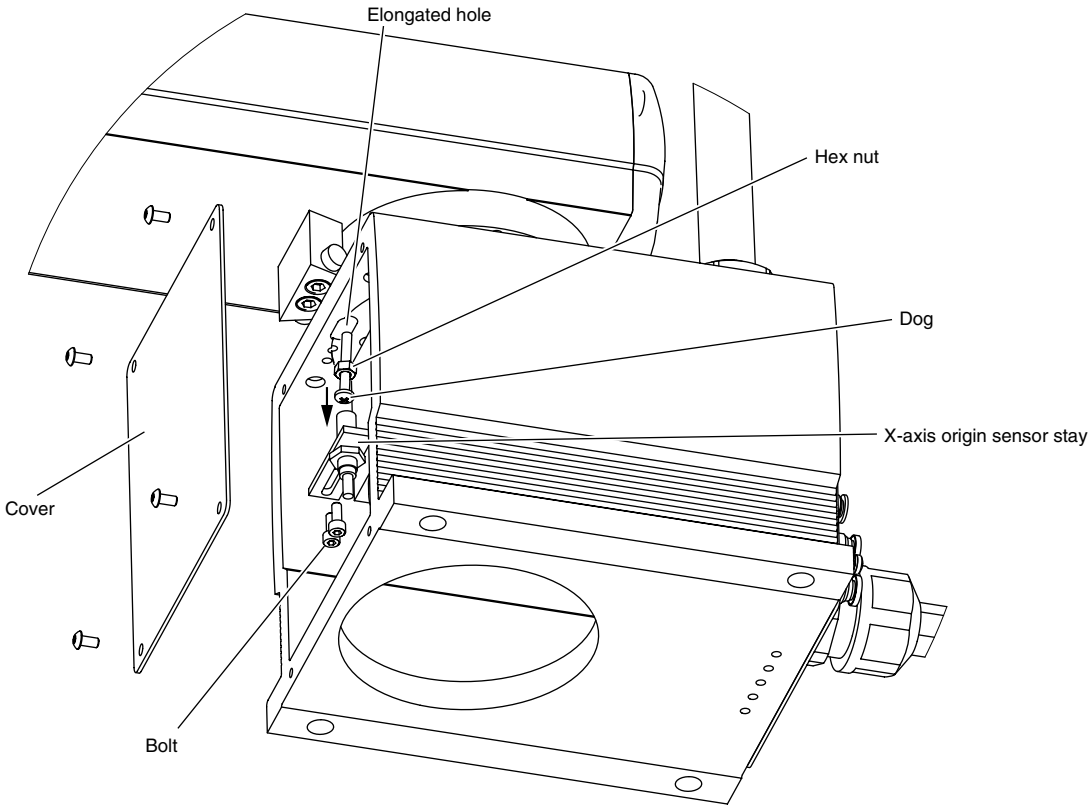


Fig. 4-5 (a)

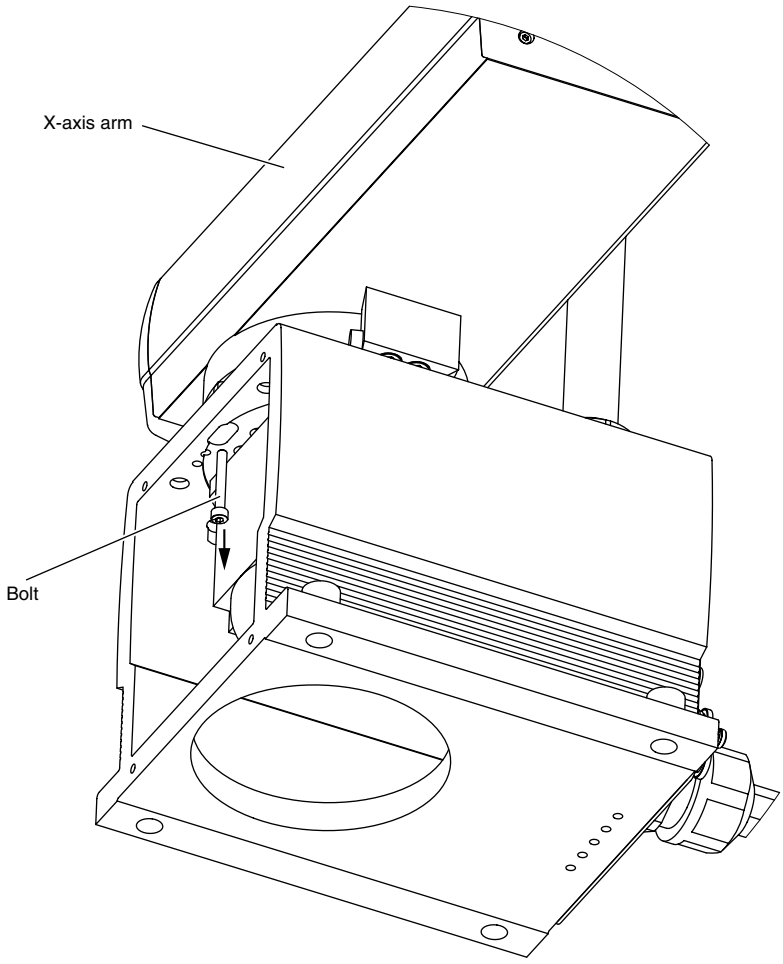
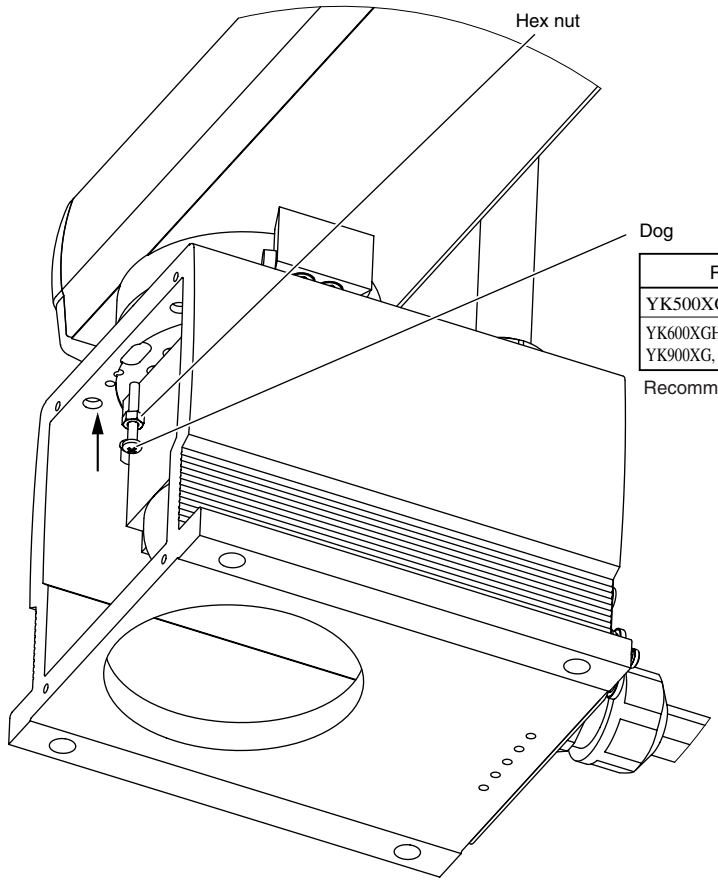


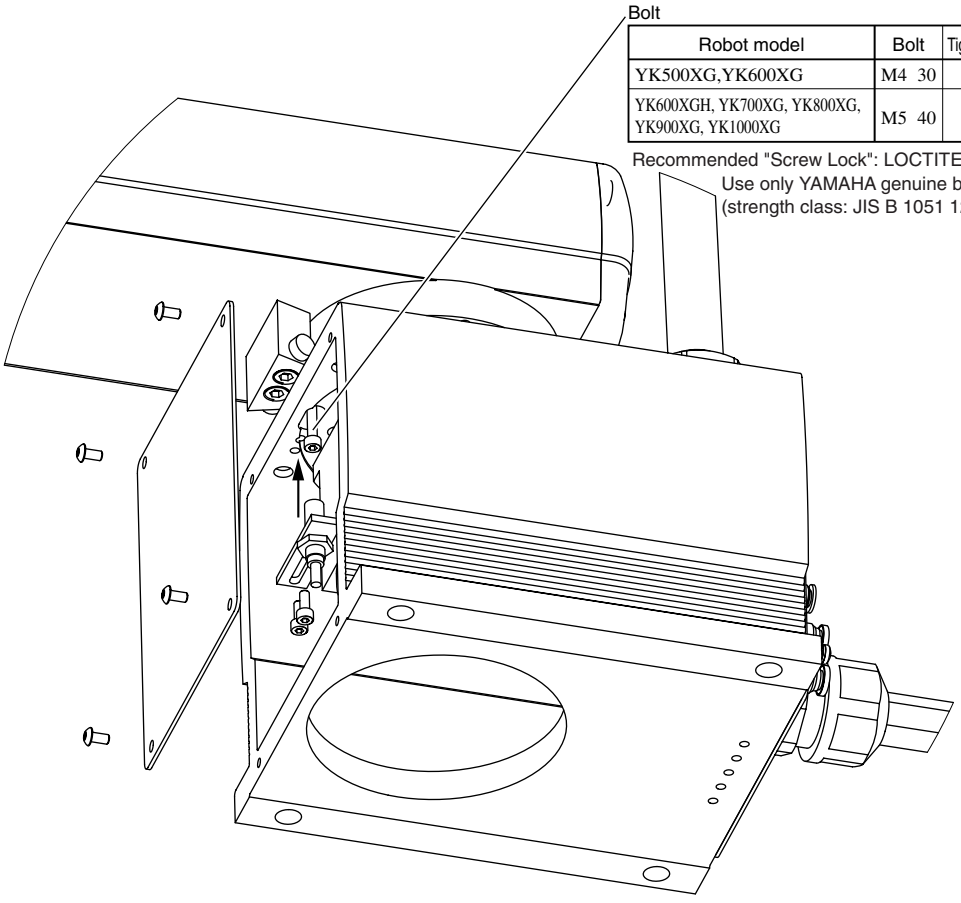
Fig. 4-5 (b)



Robot model	Dog	Tightening torque (kgfcm)	Tightening torque (cNm)
YK500XG,YK600XG	M4 30	16	160
YK600XGH, YK700XG, YK800XG, YK900XG, YK1000XG	M5 40	32	320

Recommended "Screw Lock": LOCTITE 262 (made by Henkel Corporation)

Fig. 4-5 (c)



Robot model	Bolt	Tightening torque (kgfcm)	Tightening torque (Nm)
YK500XG,YK600XG	M4 30	46	4.5
YK600XGH, YK700XG, YK800XG, YK900XG, YK1000XG	M5 40	92	9.0

Recommended "Screw Lock": LOCTITE 262 (made by Henkel Corporation)
Use only YAMAHA genuine bolts or JIS B 1176 hex socket head bolts (strength class: JIS B 1051 12.9).

Fig. 4-5 (d)

2-1 Adjusting the Y-axis machine reference

⚠CAUTION

The origin position may change due to machine reference adjustment. If it occurs, you must set point data again.

The adjustment method for the Y-axis machine reference is as follows.

1) Prepare a hex wrench set.

2) Check that no one is inside the safeguard enclosure and then turn on the controller.

3) Perform the absolute reset from outside the safeguard enclosure.
Refer to "3-3 Absolute reset procedures" for information about the absolute reset method.

4) If any machine reference value displayed on the MPB is not in the range between 40 and 60 (recommended range) after the absolute reset has been completed, then proceed with the following adjustment procedure.

5) Place a sign indicating that the robot is being adjusted in order to keep others from operating the controller or operation panel.

6) Turn off the controller and enter the safeguard enclosure.

7) Mark off the reference mark at the current origin position on the Y-axis joint area of the robot.
At this time, be careful to prevent the origin position from deviating since the Y-axis arm is touched.

8) Remove the cover.

9) Scribe a mark on the position of the Y-axis origin sensor stay.

10) Using the hex wrench, loosen the two bolts securing the Y-axis origin sensor stay. (See Fig. 4-6.)

⚠CAUTION

The bolts only need to be loosened, and do not need to be completely removed.

11) Move the Y-axis origin sensor stay in the following manner and then secure it with the bolts.

NOTE

- When the machine reference is less than 40%, move the stay in direction ①: See Fig. 4-6.
- When the machine reference is more than 40%, move the stay in direction ②: See Fig. 4-6.

As an approximate guide, a 0.8mm movement equals to 100%.

12) Go out of the safeguard enclosure, and check that no one is inside the safeguard enclosure. Then turn on the controller.

13) Perform the absolute reset from outside the safeguard enclosure.

14) After the absolute reset is completed, read the machine reference value displayed on the MPB.

15) If the machine reference value is in the range between 40 and 60 (recommended range), then the machine reference has been completely adjusted. If it is outside the recommended range, then repeat the procedure that starts in 5) to readjust it.

16) Reattach the cover after the adjustment is complete.

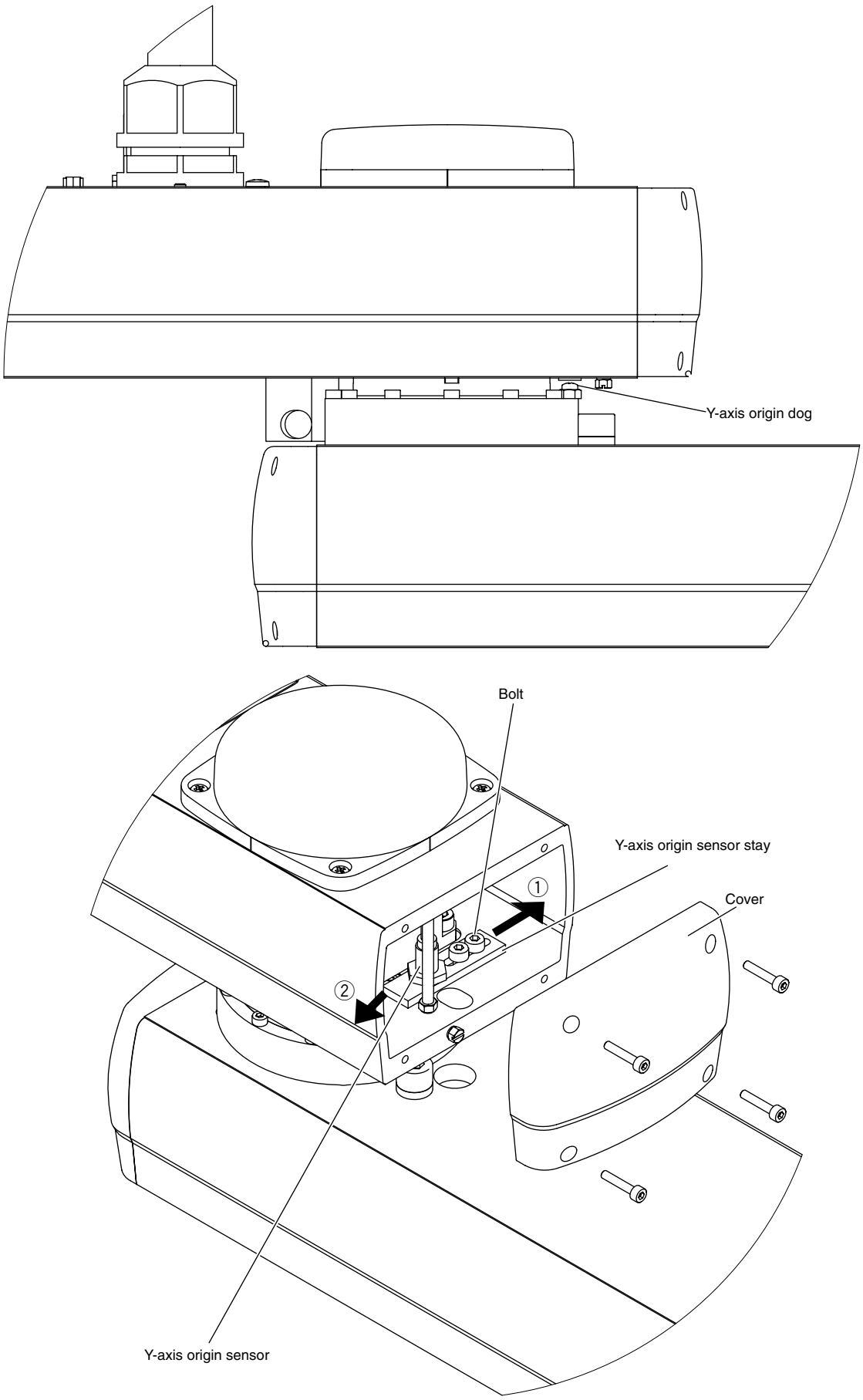

Y-axis origin dog
Bolt
Y-axis origin sensor stay
Cover
①
②
Y-axis origin sensor

Fig. 4-6

2-2 Changing the Y-axis origin position

The Y-axis origin position can be changed to any position in the range from the front position of the Y-axis arm and X-axis arm to a maximum of 120° clockwise and counterclockwise at 30° intervals, by changing the positions of the dog and the mounting bolt for the Y-axis speed reduction unit as shown in Fig. 4-7.

⚠CAUTION

- If the origin position has been changed, then the absolute reset must be performed, the machine reference must be adjusted, and the standard coordinate and point data must be reset.
- The dog and bolt might come off and cause the joint to lock up unless you apply "Screw Lock" to them and tighten to the specified torque.

The following describes the method for changing the Y-axis origin position, for example, to a position 90° counterclockwise.

1) Prepare the necessary tools.
   - Hex wrench set
   - Phillips screwdriver
   - Phillips screwdriver bit
   - Torque wrench
   - Screw Lock (thread sealant)
   - Hex bit
2) Check that no one is inside the safeguard enclosure and then turn on the controller.
3) Perform the absolute reset from outside the safeguard enclosure.
   Refer to "3-3 Absolute reset procedures" for information about the absolute reset method.
4) Place a sign indicating that the robot is being adjusted in order to keep others from operating the controller or operation panel.
5) Turn off the controller and enter the safeguard enclosure.
6) Remove the cover. (See Fig. 4-8 (a).)
7) Using the hex wrench, loosen the two bolts securing the Y-axis origin sensor stay.
8) Remove the Y-axis origin sensor stay.
9) Remove the dog and hex nut through the elongated hole. (See Fig. 4-8 (b).)
   We recommend using the Phillips screwdriver bit and wrench to remove the dog since it is secured with "Screw Lock".
10) Rotate the Y-axis arm 90° counterclockwise. (See Fig. 4-8 (c).)
11) Remove the bolt located opposite the elongated hole.
12) Apply "Screw Lock" to the dog and nut, insert them into the tapped hole where the bolt was attached, and tighten to the specified torque. (See Fig. 4-8 (d).)
13) Return the Y-axis arm to the current origin position. (See Fig. 4-8 (e).)
14) Apply "Screw Lock" to the bolt, insert it into the tapped hole where the dog was attached, and tighten to the specified torque.

15) Temporarily fasten the Y-axis origin sensor stay using the bolts. At this point, check that the sensor does not interfere with any parts while turning the Y-axis arm by hand.

16) Go out of the safeguard enclosure, and check that no one is inside the safeguard enclosure. Then turn on the controller.

17) Perform the absolute reset from outside the safeguard enclosure.

18) After the absolute reset is completed, read the machine reference value displayed on the MPB.

19) If the machine reference value is in the range between 40 and 60 (recommended range), then the origin position has been correctly changed. Fully tighten the bolts to secure the Y-axis origin sensor stay. If it is outside the recommended value, then adjust the machine reference by referring to "2-1 Adjusting the Y-axis machine reference".

20) Reattach the cover after the adjustment is complete.

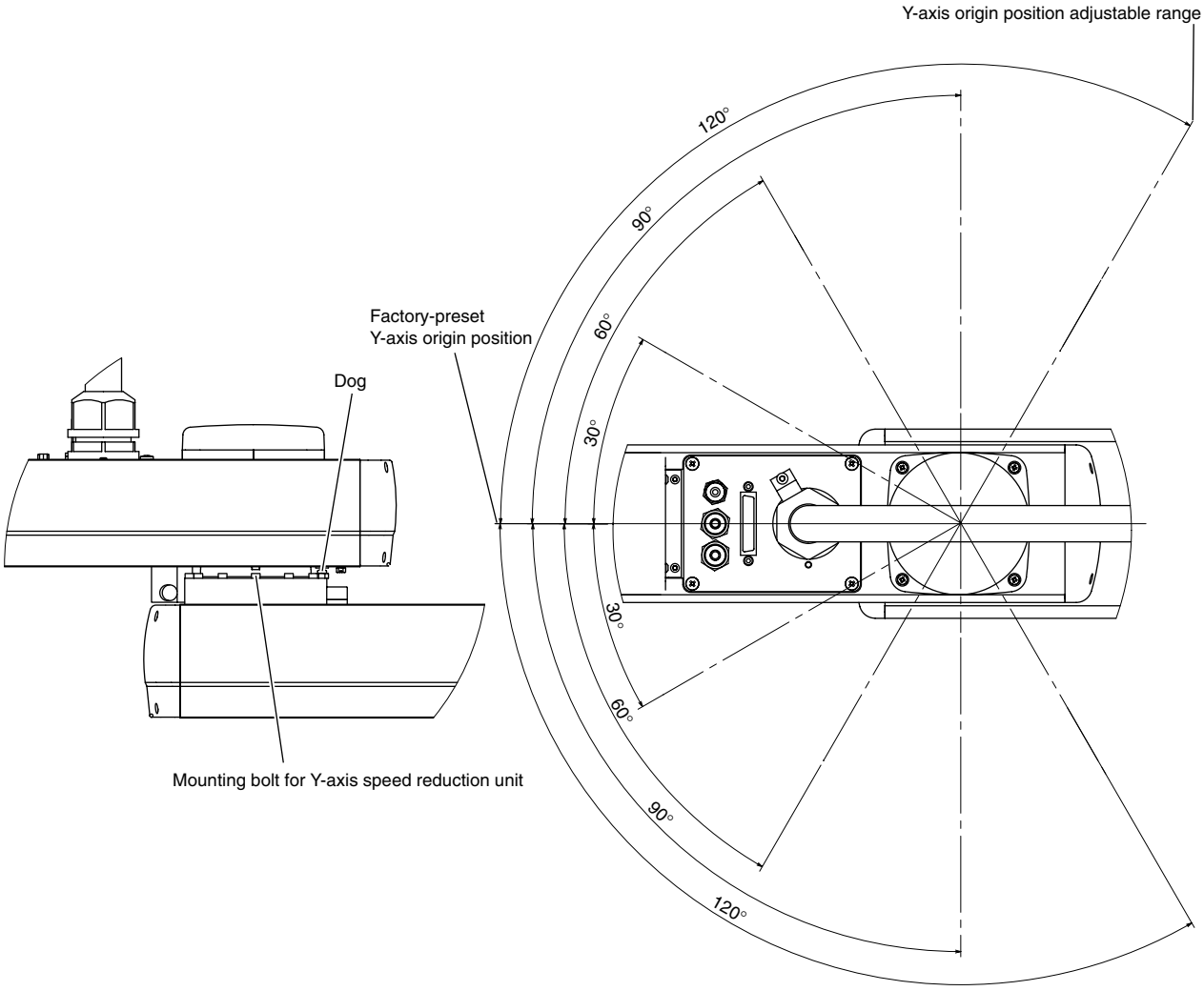


Fig. 4-7

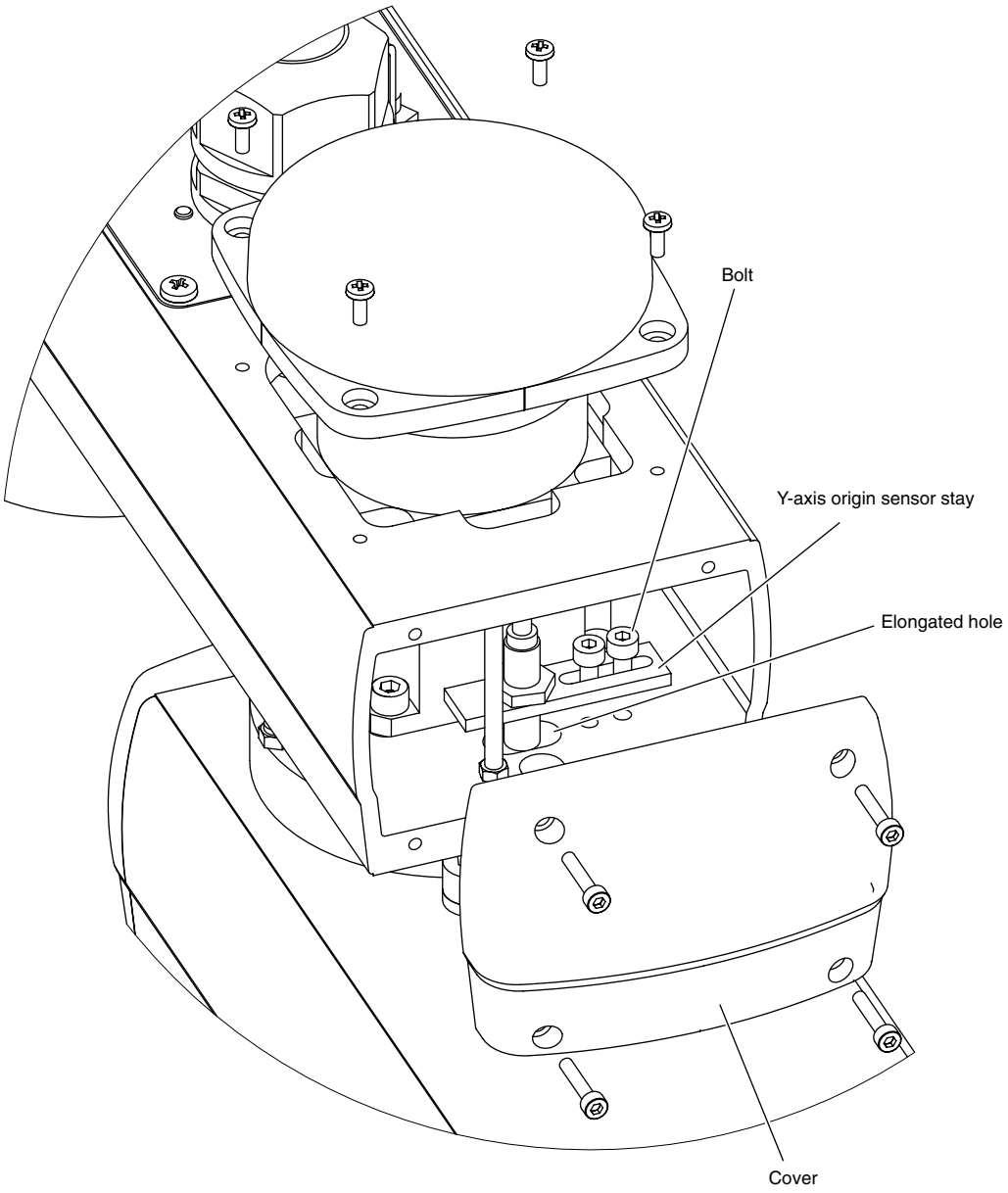


Fig. 4-8 (a)

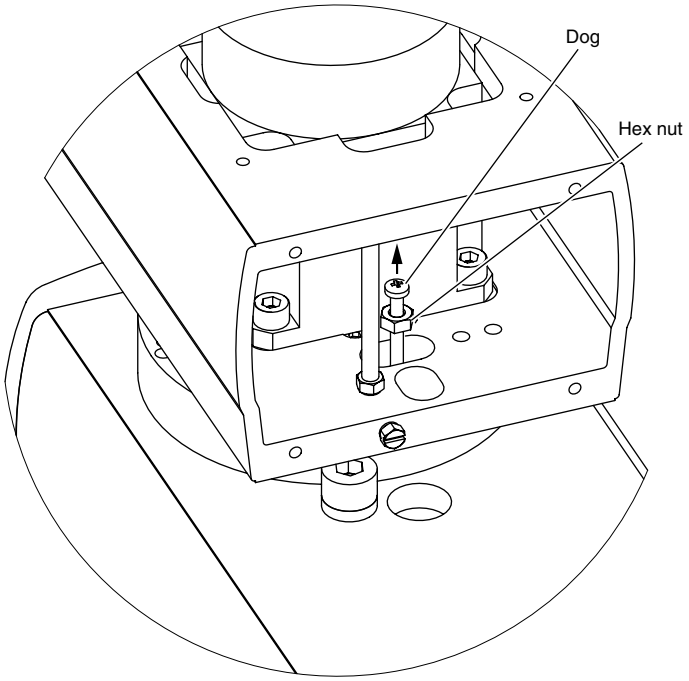


Fig. 4-8 (b)

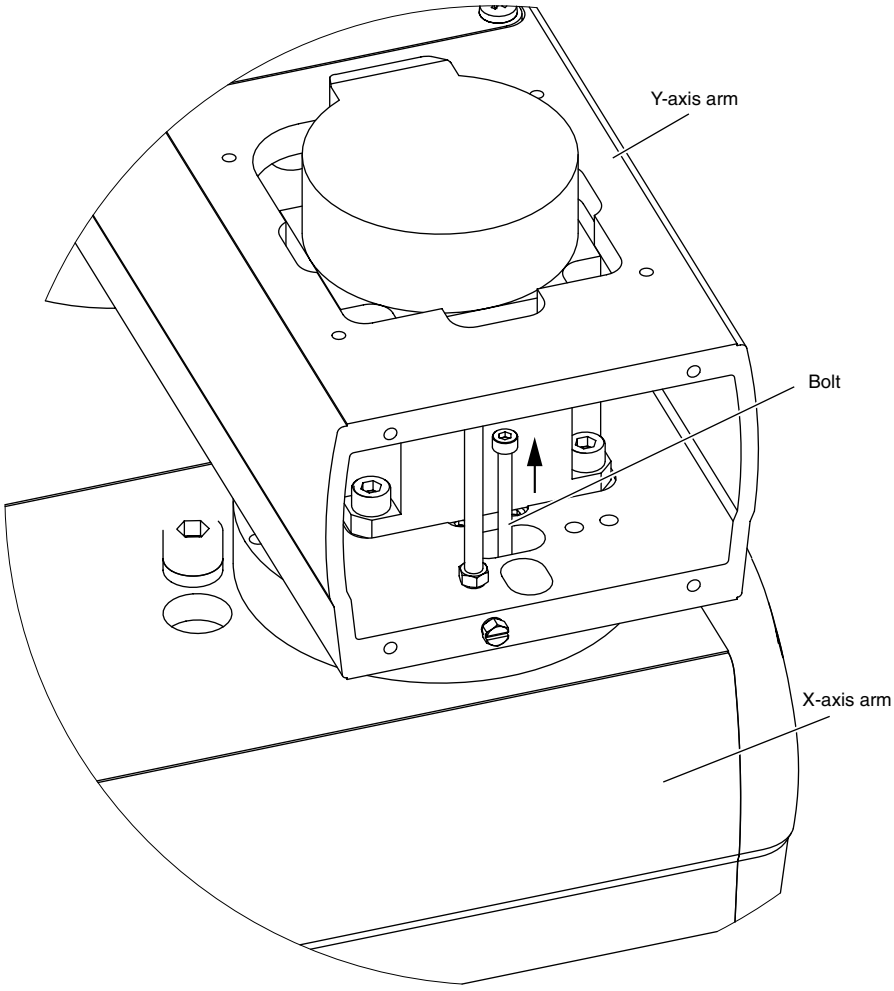
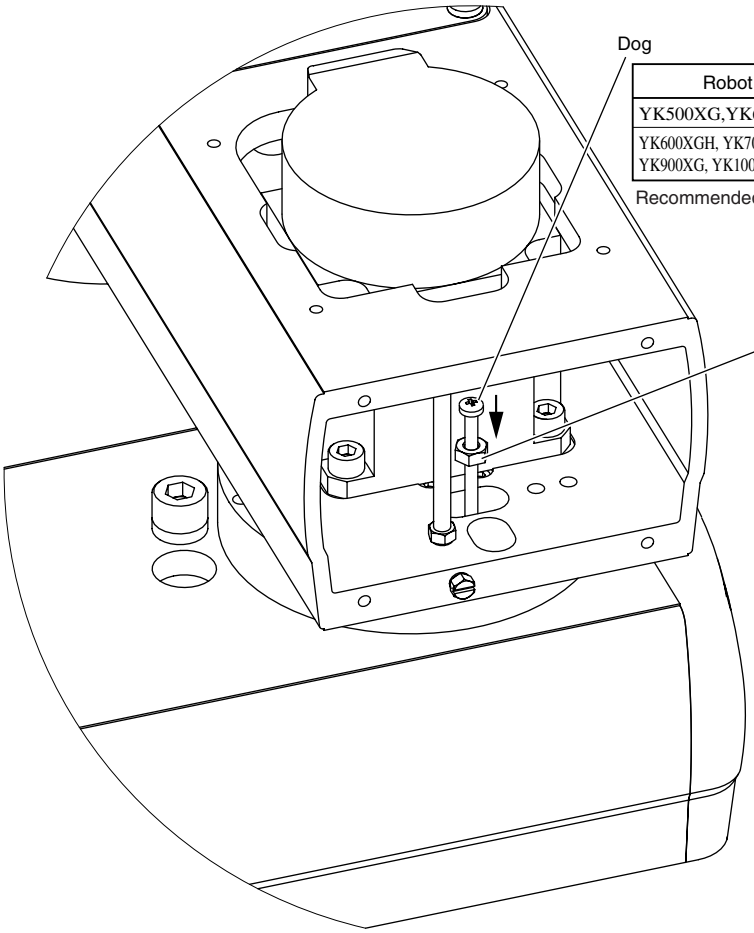


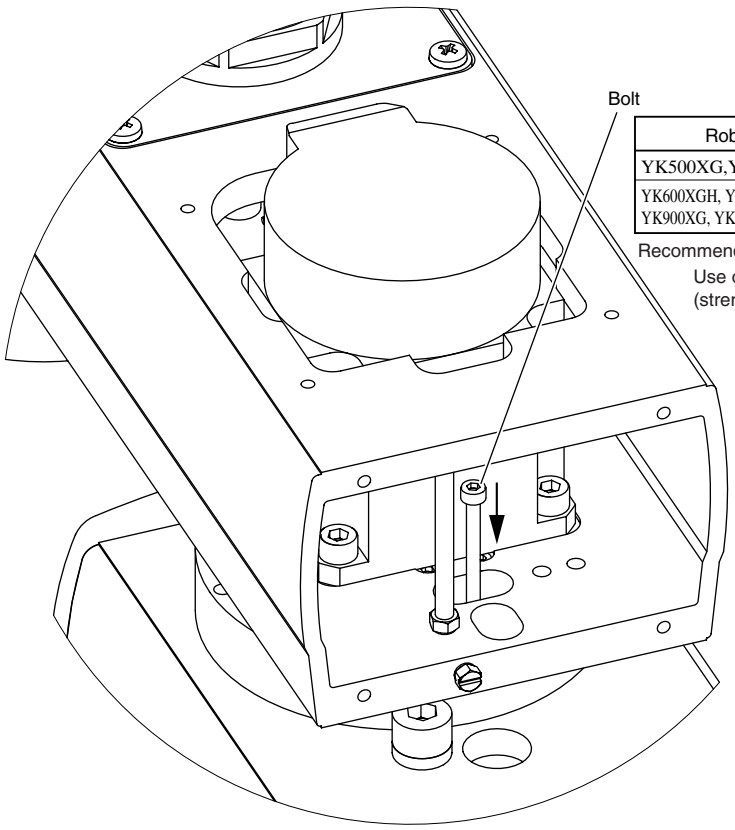
Fig. 4-8 (c)



Robot model	Dog	Tightening torque (kgfcm)	Tightening torque (cNm)
YK500XG,YK600XG	M3 30	9	90
YK600XGH, YK700XG, YK800XG, YK900XG, YK1000XG	M4 30	16	160

Recommended "Screw Lock": LOCTITE 262 (made by Henkel Corporation)

Fig. 4-8 (d)



Robot model	Bolt	Tightening torque (kgfcm)	Tightening torque (Nm)
YK500XG,YK600XG	M3 30	20	2.0
YK600XGH, YK700XG, YK800XG, YK900XG, YK1000XG	M4 30	46	4.5

Recommended "Screw Lock": LOCTITE 262 (made by Henkel Corporation)
Use only YAMAHA genuine bolts or JIS B 1176 hex socket head bolts (strength class: JIS B 1051 12.9).

Fig. 4-8 (e)

3 Adjusting the R-axis machine reference

The adjustment method for the R-axis machine reference is as follows.

1) Prepare a hex wrench set.

2) Check that no one is inside the safeguard enclosure and then turn on the controller.

3) Perform the absolute reset from outside the safeguard enclosure.
Refer to "3-3 Absolute reset procedures" for information about the absolute reset method.

4) If any machine reference value displayed on the MPB is not in the range between 40 and 60 (recommended range) after the absolute reset has been completed, then proceed with the following adjustment procedure.

5) Place a sign indicating that the robot is being adjusted in order to keep others from operating the controller or operation panel.

6) Turn off the controller and enter the safeguard enclosure.

7) Mark off the reference mark at the current origin position on the R-axis area of the robot.
At this time, be careful not to touch the tool at the tip of the robot arm so that the origin position does not shift.

8) Remove the cover.

9) Scribe a mark on the position of the R-axis origin sensor stay.

10) Using the hex wrench, loosen the two bolts securing the R-axis origin sensor stay. (See Fig. 4-9.)

⚠CAUTION

The bolts only need to be loosened, and do not need to be completely removed.

11) Move the R-axis origin sensor stay in the following manner and then secure it with the bolts.

NOTE

- When the machine reference is less than 40%, move the stay in direction ①: See Fig. 4-9.
- When the machine reference is more than 40%, move the stay in direction ②: See Fig. 4-9.

As an approximate guide, a 1.9mm movement equals to 100%.

12) Go out of the safeguard enclosure, and check that no one is inside the safeguard enclosure. Then turn on the controller.

13) Perform the absolute reset from outside the safeguard enclosure.

14) After the absolute reset is completed, read the machine reference value displayed on the MPB.

15) If the machine reference value is in the range between 40 and 60 (recommended range), then the machine reference has been completely adjusted.
If it is outside the recommended range, then repeat the procedure that starts in 5) to readjust it.

16) Reattach the cover after the adjustment is complete.

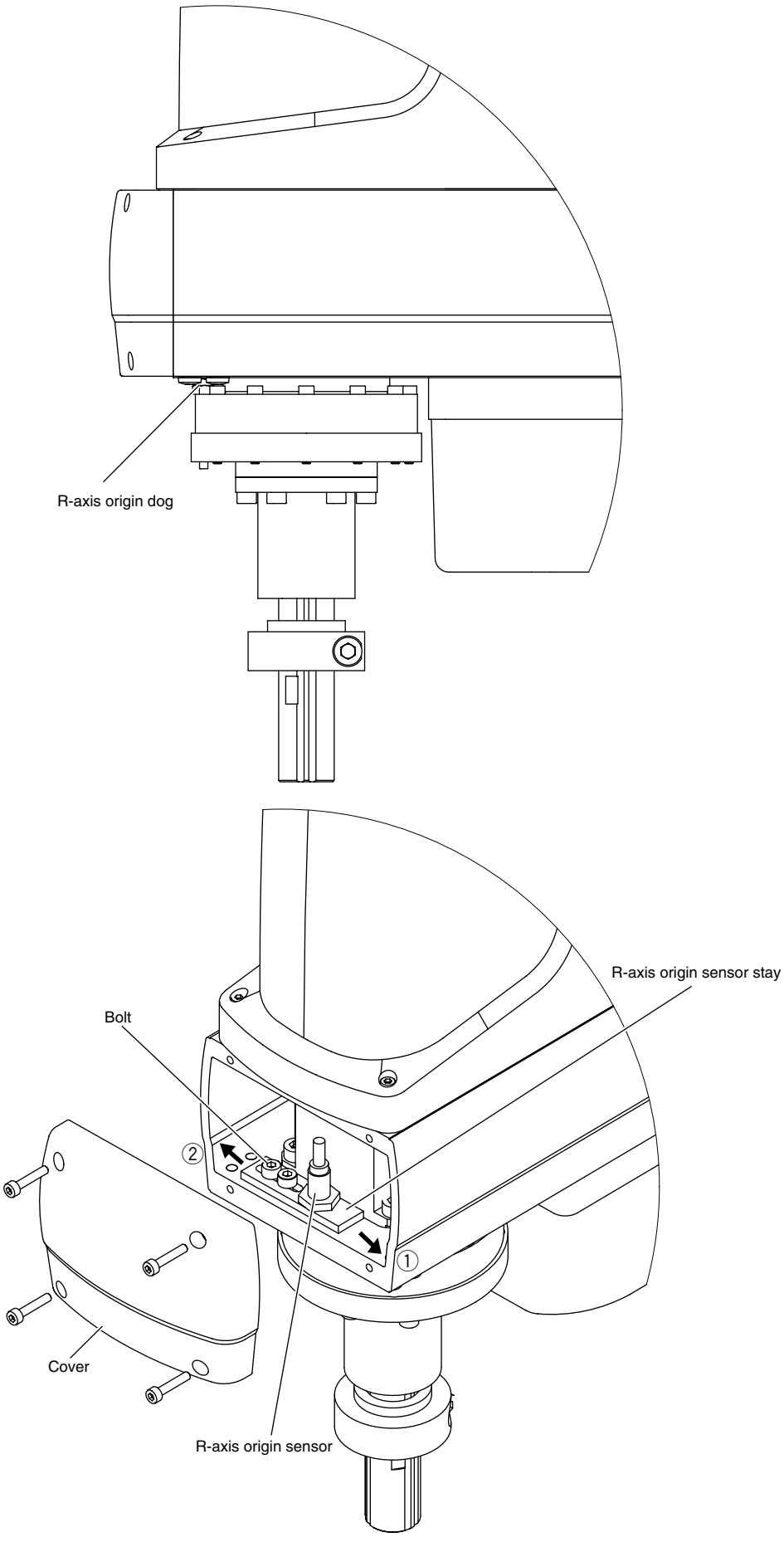

R-axis origin dog
R-axis origin sensor stay
Bolt
②
①
Cover
R-axis origin sensor

Fig. 4-9

3-4-2 Stroke end method

The stroke end method is employed on the YK-XG series robots for the absolute reset of the Z-axis. The origin position of the Z-axis is fixed at the upper end of the Z-axis stroke, and it cannot be changed. The machine reference is factory-adjusted at shipment, and readjustment is not necessary for normal use. The readjustment in the following procedure is required, however, if the machine reference exceeds the tolerance range (33 to 67) of the absolute reset for any reason.

⚠CAUTION

The origin position may change due to machine reference adjustment. If it occurs, you must set point data again.

3-4-2-1 YK500XG, YK600XG, YK600XGH, YK700XG, YK800XG, YK900XG, YK1000XG

1) Check that no one is inside the safeguard enclosure, and then turn on the controller.

2) Place a sign indicating the robot is being adjusted, to keep others from operating the controller or operation panel.

3) Perform the Z-axis absolute reset.
To perform the Z-axis absolute reset, see "3-3 Absolute reset procedures" in Chapter 4. Make a note of the Z-axis machine reference value.

⚠CAUTION

Use the following procedure to display the **adjustment machine reference value**.
When **adjusting the machine reference value**, always check the **adjustment machine reference value** with this procedure.

(1) Press the MODE key.
(2) Press the F3 key to enter MANUAL mode.
(3) Press the F13 key (LOWER+F3) to select "ABS Reset".
(4) After the Z-axis absolute reset is complete, press the F10 (UPPER+F5) key to display the **adjustment machine reference value (%)**.

4) Turn off the controller.
The Z-axis motor brake is now working at the origin position.

5) Enter the safeguard enclosure.

6) Remove the cover. (See Fig. 4-10.)

⚠ WARNING

If the ball screw comes off the Z-axis motor, the Z-axis drops causing a hazardous situation. Always prop up the Z-axis with a support stand or the like.

7) Prop the spline or end effector with a support stand to prevent the Z-axis from dropping.

8) Lift up the Z-axis lower end damper. If this is difficult, insert a screwdriver between the damper and the holder, and pry up the damper. (See Fig. 4-11 (a).)

9) Put a mark to indicate the current flange position with respect to the motor shaft. Fit the spanner (wrench) to the flat surfaces of the flange and loosen the bolts. This allows the ball screw to rotate freely independent of the Z-axis motor.

10) Rotate the flange with respect to the motor shaft. (See Fig. 4-11 (b).)
Rotating the flange 30 degrees changes the machine reference value by 33%. The machine reference value decreases by rotating the flange clockwise as viewed from top, while it increases by rotating the flange counterclockwise. Determine the flange position based on the Z-axis machine reference value you made a note of, so that the machine reference value is within 33 to 67%.

11) Tighten the bolts a little at a time in a diagonal pattern. The tightening torque should be 2.0Nm (20kgfcm). The bolts can be inserted into 10 holes among 12 through-holes.

12) Go outside the safeguard enclosure.

13) Check that no one is inside the safeguard enclosure, and then turn on the controller.

14) Perform the Z-axis absolute reset.
To perform the Z-axis absolute reset, see "3-3 Absolute reset procedures" in Chapter 4.
After absolute reset is complete, check that the **adjustment machine reference value** is within the tolerance range (33 and 67). If the **adjustment machine reference value** is outside the tolerance range (33 to 67), then repeat the procedure from 4) to readjust it.

15) When the machine reference value is within the tolerance range, lower the Z-axis lower end damper until it makes tight contact with the holder and then reattach the cover.

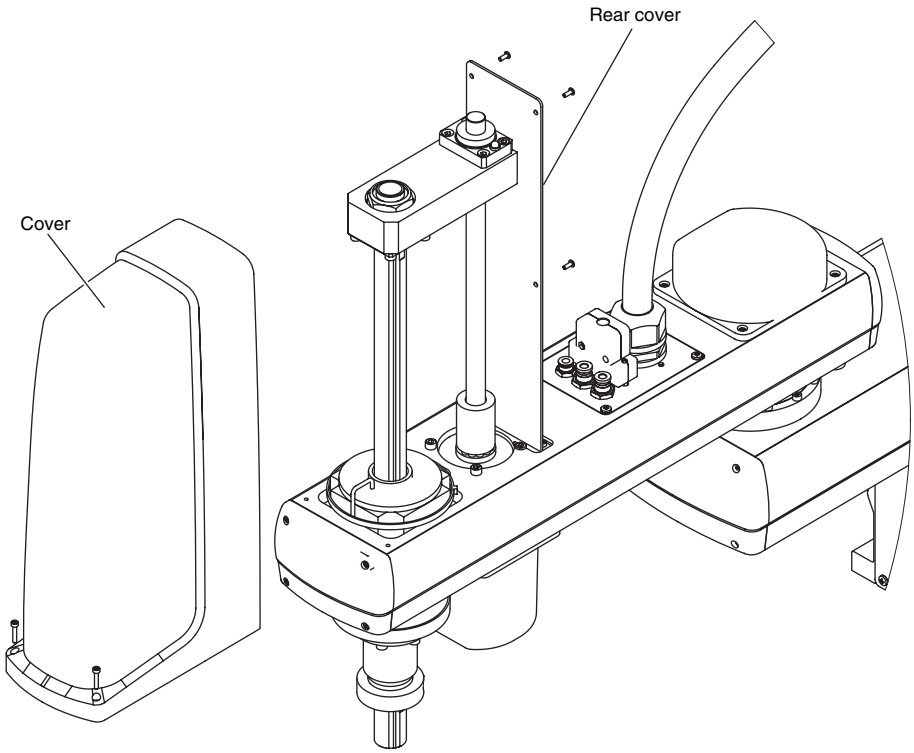


Fig. 4-10

Use only YAMAHA genuine bolts or JIS B 1176 hex socket head bolts (strength class: JIS B 1051 12.9).

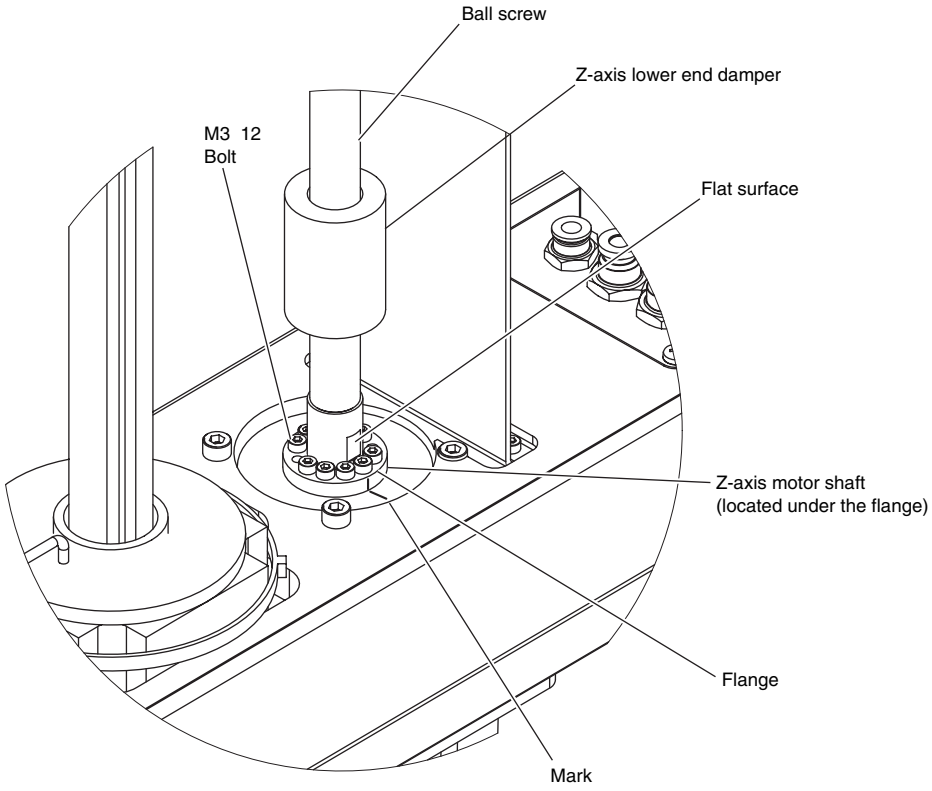


Fig. 4-11 (a)

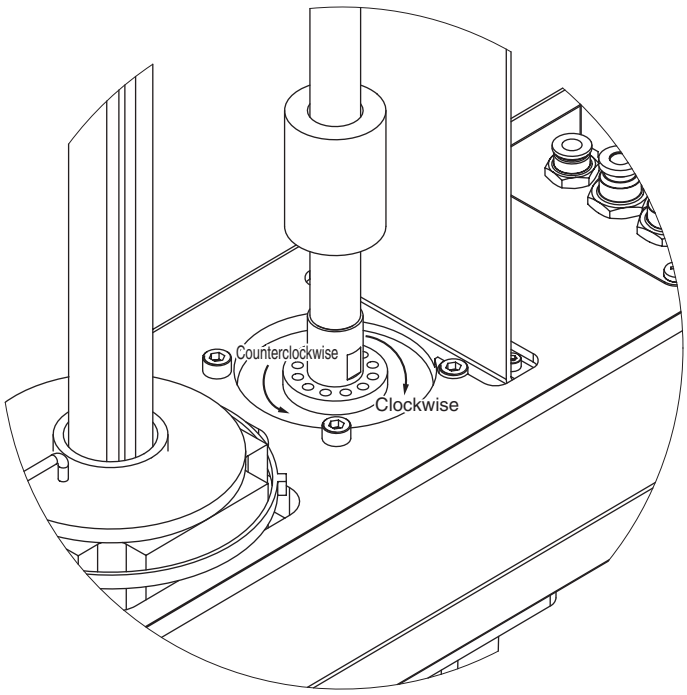


Fig. 4-11 (b)

4 Setting the Soft Limits

In the YK-XG Series, the working envelope during manual and automatic operation can be limited by setting the plus soft limit [pulse] and minus soft limit [pulse] on each axis. The origin point (0 [pulse])is used as the reference to set the soft limits. The working envelope can be limited by specifying the number of pulses from the 0 pulse position. For the working envelope of each robot, refer to "1-2 External view and dimensions" in Chapter 7.

Also refer to the external view and dimensions in the catalog or website (www.yamaha-motor.co.jp/global/industrial/robot) for the working envelope area. When performing actual checks of the soft limit settings, operate the robot manually from outside the safeguard enclosure.

(1) Setting the X-axis and Y-axis soft limits

The soft limits must be set within the movement range limited by the mechanical stoppers as explained in Section 7 in Chapter 3 or within the range where the manipulator does not interfere with the peripheral equipment (but within maximum working envelope). Set the soft limits with the following procedure. Also use this procedure when the origin position has been changed. Likewise, in models where the mechanical stopper position cannot be changed, reduce the soft limits to narrow the working envelope when the actual working range of the robot is small or the manipulator interferes with the peripheral equipment.

1) Check that no one is inside the safeguard enclosure, and then turn on the controller.

2) Press the emergency stop button on the MPB to set emergency stop.
Refer to the "YAMAHA Robot Controller User's Manual" for further details on emergency stop and canceling emergency stop.

3) Place a sign indicating the robot is being adjusted, to keep others from operating the controller or operation panel.

4) Enter the safeguard enclosure while holding the MPB.

5) Move the X-axis and Y-axis arms by hand to the mechanical stopper positions or to the point where interference with the peripheral equipment occurs, and note the X-axis and Y-axis plus (+) and minus (-) direction pulses displayed on the MPB.

6) Check that no one is inside the safeguard enclosure, then cancel emergency stop from outside the safeguard enclosure.

7) Set the soft limits to within the figure for the X-axis and Y-axis encoder pulses that you noted above in step 5).
This software limit setting must be made from outside the safeguard enclosure. Refer to the "YAMAHA Robot Controller User's Manual" for further details on soft limit settings.

⚠CAUTION

The origin position factory-adjusted at shipment is not completely aligned with the front face position of the robot. When introducing the robot, be sure to set the soft limits with the number of pulses from the origin position (0 pulse position).

(2) Setting the Z-axis soft limits

Make this setting from outside the safeguard enclosure. The Z-axis has mechanical stoppers fixed at the upper and lower ends of the Z-axis movement range. When the actual working range of the robot is smaller than the maximum working envelope or the manipulator interferes with the peripheral equipment, reduce the Z-axis plus (+) soft limit [pulses] to narrow the working envelope.

(3) Setting the R-axis soft limit

To make this setting, set emergency stop just as for the X-axis and Y-axis, or be sure to do this from outside the safeguard enclosure. The R-axis has no mechanical stoppers. When the actual working range of the R-axis is small or it interferes with the peripheral equipment, reduce the R axis plus (+) soft limit [pulse] and minus (-) soft limit [pulses] to narrow the working envelope.

⚠CAUTION

Overloads may occur if the soft limit is almost near the encoder pulse at the mechanical stopper and the operating point is used at the edge of the movement range. Set the soft limit to the inner side of the mechanical stopper with an ample safety margin.

(4) Relation between the X, Y and R-axis movement angle, the Z-axis movement distance and the number of pulses

The tables below are for calculating resolver pulses with respect to the X, Y and R-axis movement angles and to the Z-axis movement distance for each robot. Use these figures as a guide to set the soft limits.

X, Y and R-axis speed reduction ratio and Z-axis ball screw lead for each robot

Robot model	X-axis	Y-axis	Z-axis	R-axis
YK500XG, YK600XG	80	80	20mm	30
YK600XGH, YK700XG, YK800XG, YK900XG, YK1000XG	80	80	20mm	50

Operation angle/distance vs. number of resolver pulses
X, Y and R-axis speed reduction ratio

Speed ratio	Number of resolver pulses per turn (360 degrees)
30	491520
50	819200
80	1310720
100	1638400
105	1720320
121	1982464

Z-axis

Lead	Number of resolver pulses per lead movement
10mm	16384
12mm	16384
20mm	16384
30mm	16384

5 Setting the Standard Coordinates

⚠CAUTION

If the standard coordinate settings are incorrect, the acceleration cannot be optimized to match the arm position. This results in too short a service life, damage to the drive unit, or residual vibration during positioning. In addition, the cartesian coordinate accuracy will be impaired.

Setting the standard coordinates enables the following operations and functions.

1. Optimizes acceleration according to arm position during automatic op eration.
2. Allows moving robot arm tip at right angles.
3. Allows using shift coordinates.
4. Enables commands such as linear interpolation and arm switching.

The procedure for setting standard coordinates and cautions are shown below.

1) Check that no one is inside the safeguard enclosure, and then turn on the controller.

2) Check that the soft limits are correctly set.
If not correctly set, adjust the soft limits while referring to the description of "4 Setting the Soft Limits" in Chapter 4.

3) Place a sign indicating the robot is being adjusted, to keep others from operating the controller or operation panel.

4) Enter the safeguard enclosure while holding the MPB. Stay outside the robot movement range at this time.

5) Make the standard coordinate settings while referring to methods for "Setting the Standard Coordinates" as explained in the "YAMAHA Robot Controller User's Manual".
Never enter within the robot movement range. The next section, "5-1 Standard coordinate setting using a standard coordinate setup jig (option)", describes how to set the standard coordinates more accurately using an optional setup jig.

6) When the standard coordinate settings are complete, check the following points from outside the safeguard enclosure.
   1. Check that the robot arm tip can move at right angles in MANUAL operation (cartesian coordinates).
   2. Check that the values nearly equal to the X-axis and Y-axis arm lengths are entered in "Arm length" of the axis parameters.

   If the above points are not satisfied, the standard coordinate settings are incorrect, so make the standard coordinate settings again.

5-1 Standard coordinate setting using a standard coordinate setup jig (option)

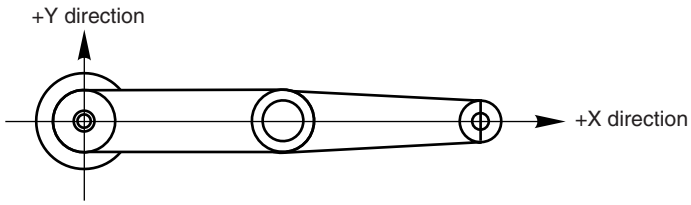


Fig. 4-12

1) Check that no one is inside the safeguard enclosure, and then turn on the controller.

2) Press the emergency stop button on the MPB to set emergency stop.
Refer to the "YAMAHA Robot Controller User's Manual" for further details on emergency stop and canceling emergency stop.

3) Place a sign indicating the robot is being adjusted, to keep others from operating the controller or operation panel.

4) Enter the safeguard enclosure while holding the MPB.

5) Position the robot arms as shown in Fig. 4-13 and remove the screw.

6) Position the robot arms so that you can easily insert the sleeve into the hole, and insert the sleeve into the hole. Then tighten the bolt just enough to hold the sleeve. (See Fig. 4-14.)

7) Turn the X and Y-axis arms so that they are nearly straight. (See Fig. 4-15.) Remove the cover and plate.

8) Position the Y-axis arm so that you can easily insert the pin into the sleeve through the elongated hole in the Y-axis arm. (See Fig. 4-16.) Secure the pin with the bolt. Tighten the bolt just enough to hold the pin.

9) Enter "MANUAL>POINT" mode. Lightly apply a clockwise torque to the Y-axis to unload it while holding the X-axis arm, and make a note of the Y-axis position pulse value displayed on [POS].

10) Lightly apply a counterclockwise torque to the Y-axis to unload it while holding the X-axis arm, and make a note of the Y-axis position pulse value displayed on [POS].

11) Move the X-axis arm in the direction that you want to set as the + direction of the X-axis as shown in Fig. 4-12. At this point, make a note of the X-axis position pulse value displayed on [POS].

12) Enter the following values in M1 and M2 for "11. Arm length [mm]" of axis parameters.

	M1 (X-axis arm length)	M2 (Y-axis arm length)
YK500XG	200.00	300.00
YK600XG	300.00	300.00
YK600XGH	200.00	400.00
YK700XG	300.00	400.00
YK800XG	400.00	400.00
YK900XG	500.00	400.00
YK1000XG	600.00	400.00

13) Enter the following values in "12. Offset pulse" of axis parameters.

M1= X-axis position pulse value you made a note of in step 11)

$$M2 = \frac{\text{Y-axis position pulse value you made a note of in step 9)} + \text{Y-axis position pulse value you made a note of in step 10)}}{2}$$

Round off the decimal part of the M2 value.

14) After entering the parameters, remove the pin, bolt, and sleeve. Reattach the cover, plate and screw.

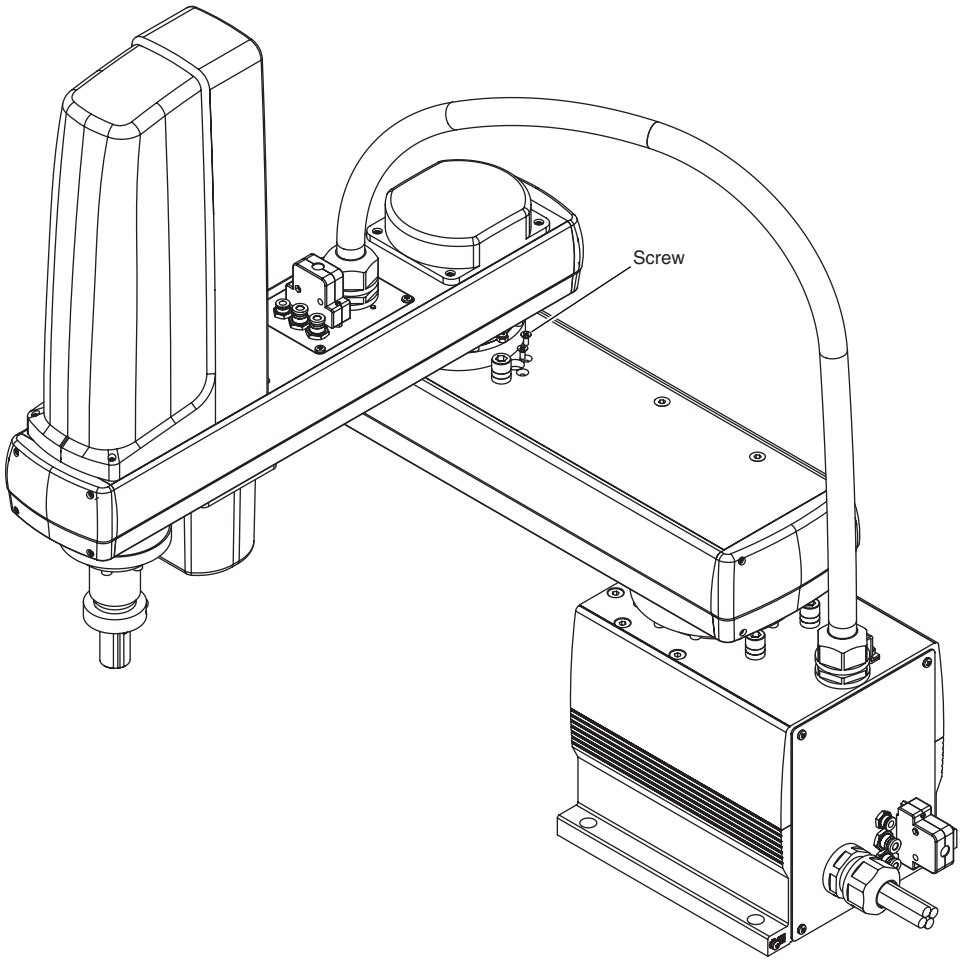


Fig. 4-13

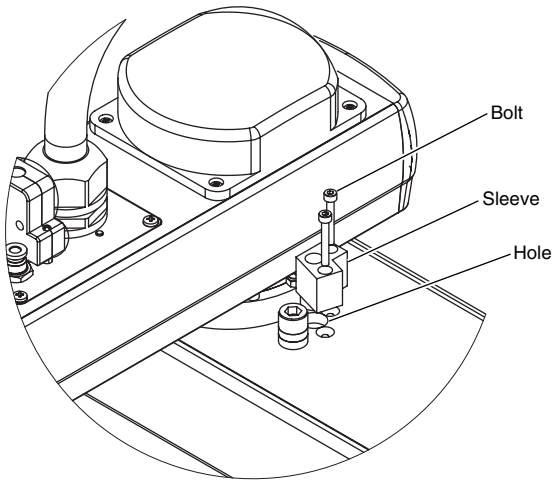


Fig. 4-14

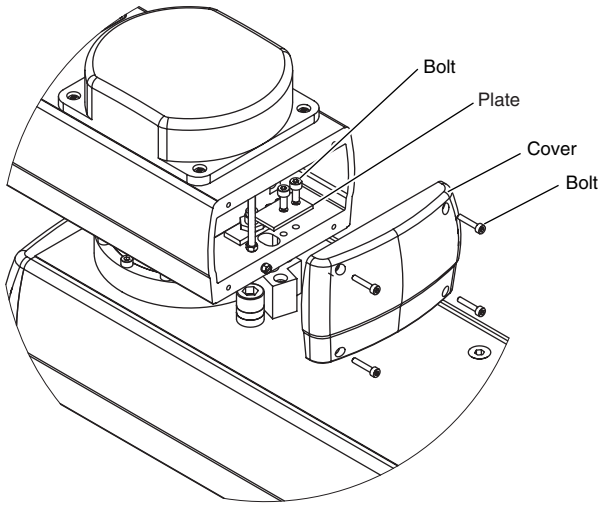


Fig. 4-15

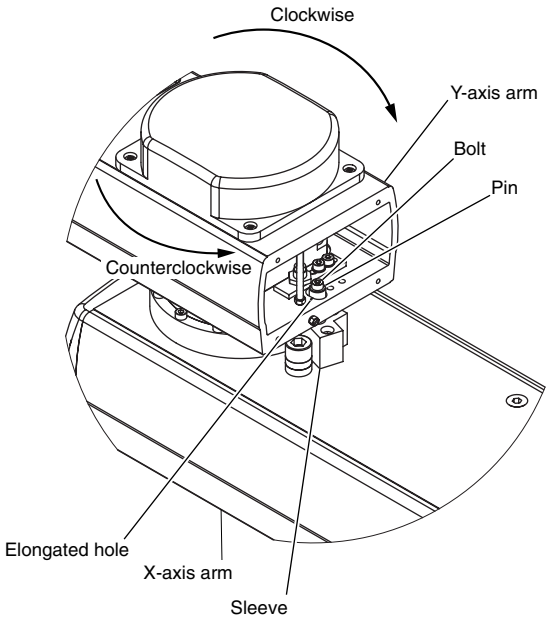


Fig. 4-16

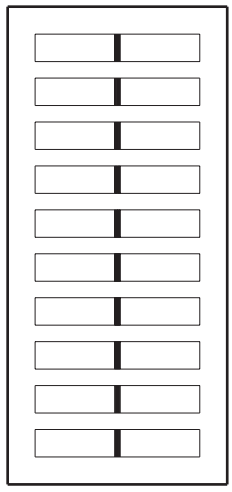
6 Affixing the Stickers for Movement Directions and Axis Names

The robot comes packed with stickers showing origin positions, movement directions and axis names as shown in Fig. 4-17. Using the following procedure, attach these stickers in conspicuous points on the robot after changing the origin position and installing peripheral equipment.

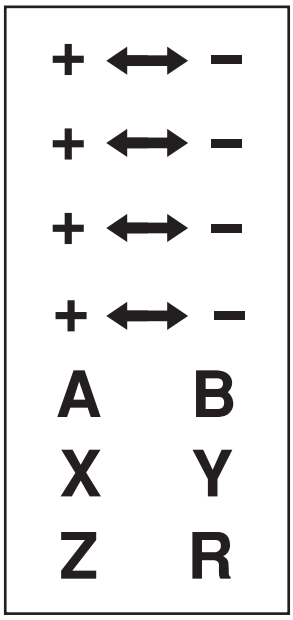
1) Check that no one is inside the safeguard enclosure, and then turn on the controller.
2) Move the robot to the 0 pulse position.
   To move the axes to their "0" pulse positions, see "Chapter 4 Point trace function" in the "YAMAHA Robot Controller User's Manual".
3) Turn off the controller.
4) Place a sign indicating the robot is being adjusted, to keep others from operating the controller switch.
5) Enter the safeguard enclosure.
6) Being careful not to move the origin positions, attach stickers at conspicuous points on matching sides of components such as the robot arm of each axis, base (robot pedestal) and end effector. Affix stickers nearby showing the axis name and direction of movement. Use a cloth moistened with alcohol to remove grease from the surface where you will affix the stickers. After the surface is dry, affix the stickers securely. (See Fig. 4-18)

⚠ WARNING

Affix the origin position stickers precisely on the origin positions. Align the direction of movement stickers with the jog direction and affix them correctly. Affix each axis name sticker on the correct axis. Affixing the sticker at a wrong location may cause faulty operation and hazardous situations.



(a) Origin position stickers



(b) Direction of movement and axis name stickers

Fig. 4-17

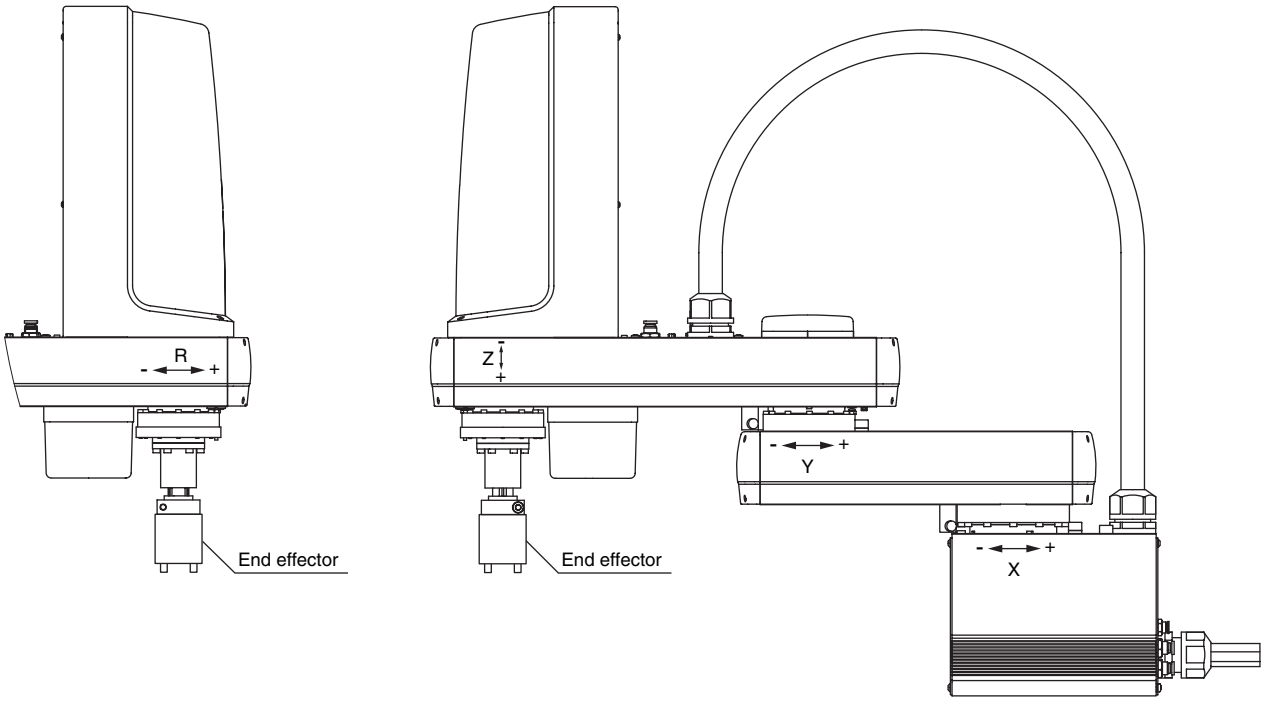


Fig. 4-18

MEMO

CHAPTER 5

Periodic Inspecition

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MEMO

1 Overview

Daily and periodic inspection of the YAMAHA robot is essential in order to ensure safe and efficient operation. This chapter describes the periodic inspection items and procedures for the YAMAHA YK-XG series robots.

Periodic inspection includes:

- Daily inspection
- 6-month inspection
- Replacement of speed reduction gear (harmonic drive)

Make sure that you thoroughly understand details of the inspection and follow the procedures and precautions explained in this chapter.

2 Precautions

(1) Periodic inspection must be performed by or in the presence of personnel who have received the Robot Training given by YAMAHA or YAMAHA dealers.

(2) Do not attempt any inspection, adjustment, repair and parts replacement not described in this manual. This work requires specialized technical knowledge and skill, and may also involve work hazards.

(3) When inspection is required inside the safeguard enclosure, always turn off the controller and also the external switch board.

(4) If the inspection or maintenance procedure calls for operation of the robot, stay outside the safeguard enclosure.

(5) Place a sign indicating the robot is being inspected, to keep others from operating the controller switch, programming unit or operation panel.

(6) Use only the lubricants specified by YAMAHA or YAMAHA dealers.

(7) To check the operation after inspection, refer to "6 Trial operation" in Chapter 1.

⚠ WARNING

- When you need to touch the terminals or connectors on the outside of the controller during inspection, always first turn off the controller power switch and also the power source in order to prevent possible electrical shock.
- Never touch any internal parts of the controller.

For precautions on handling the controller, refer to the "YAMAHA Robot Controller User's Manual".

3 Daily Inspection

The following is an inspection list that must be performed every day before and after operating the robot.

(1) Inspection to be performed with the controller turned off

1) Turn off the controller.
2) Place a sign indicating the robot is being inspected, to keep others from operating the controller switch.
3) Enter the safeguard enclosure and check the following points.

Checkpoint	Procedure
Machine harness Robot cable User cable and wiring	Check for scratches, dents and excessive bend and kinks. (If the machine harness or robot cable is damaged, contact YAMAHA dealer.)
Regulator, joints, air tube, solenoid valve, air cylinder	Check air pressure. Check for air leaks. Check drain. Check air filter for clogging or damage.
Robot exterior	Check for damage. (If a damage is found, contact YAMAHA dealer.)

(2) Inspection to be performed with the controller turned on

1) Check that no one is inside the safeguard enclosure, and then turn on the controller.
2) Place a sign indicating the robot is being inspected, to keep others from operating the controller, programming unit or operation panel.
3) Check the following points from outside the safeguard enclosure.

Checkpoint	Procedure
Safeguard enclosure	Check if the safeguard enclosure is in place. Check if emergency stop is triggered when the door is opened. Check if warning labels are affixed at the entrance and clearly visible.
Emergency stop device	Press the emergency stop button to check if it works.
Robot movement	Check for abnormal movement and excessive vibration and noise. (If any abnormal symptom is found, contact YAMAHA dealer.)
Z-axis brake operation *1	Check if the brake works to stop the Z-axis from dropping more than 3mm from the stationary point. (If any abnormal operation is found, contact YAMAHA dealer.)

*1 Visually check the Z-axis movement when you press the emergency stop button from outside the safeguard enclosure and also when you turn off the controller.

(3) Adjustment and parts replacement

1) After inspection, if you notice any adjustment or parts replacement is needed, first turn off the controller and then enter the safeguard enclosure to perform the necessary work. After adjustment or replacement is finished, again review the checkpoints outlined in (1) and (2) above.

2) If repair or parts replacement is required for the robot or controller, please contact your YAMAHA dealer. This work requires specialized technical knowledge and skill, so do not attempt it by yourself.

4 Six-Month Inspection

Take the following precautions when performing 6-month inspection.

⚠ WARNING

The Z-axis will slide down when the Z-axis brake is released, causing a hazardous situation. Do not release the brake when lubricating the Z-axis parts.

When lubricating the ball screw and spline shaft, observe the following precautions.

⚠ WARNING

Precautions when handling grease:
- Inflammation may occur if this gets in the eyes.
  Before handling the grease, wear your safety goggles to ensure the grease will not come in contact with the eyes.
- Inflammation may occur if the grease comes into contact with skin. Be sure to wear protective gloves to prevent contact with skin.
- Do not take orally or eat. (Eating will cause diarrhea and vomiting.)
- Hands and fingers might be cut when opening the container, so use protective gloves.
- Keep out of the reach of children.
- Do not heat the grease or place near an open flame since this could lead to sparks and fires.

Emergency Treatment:
- If this grease gets in the eyes, wash liberally with pure water for about 15 minutes and consult a physician for treatment.
- If this grease comes in contact with the skin, wash away completely with soap and water.
- If taken internally, do not induce vomiting but promptly consult a physician for treatment.

Disposing of grease and the container:
- Proper disposal is compulsory under federal, state and local regulations. Take appropriate measures in compliance with legal regulations.
- Do not pressurize the empty container. Pressurizing may cause the container to rupture.
- Do not attempt to weld, heat up, drill holes or cut this container. This might cause the container to explode and the remaining materials inside it to ignite.

⚠ CAUTION

Unless grease specified by YAMAHA is used, the service life of the ball screw and ball spline will shorten.

(1) Inspection to be performed with the controller turned off

1) Turn off the controller.

2) Place a sign showing that the robot is being inspected, to keep others from operating the controller switch.

3) Enter the safeguard enclosure and check the following points.

Checkpoint	Procedure
Manipulator bolts and screws (Only for major bolts and screws exposed externally)	Check for looseness and tighten if necessary.*1
Detection areas of the origin sensors of the X-axis, Y-axis, and R-axis	Clean if it is dirty.
Controller	Check for looseness at each terminal and connector on the panel. (See 4 in Chapter 3.)
Grease lubrication of Z-axis ball screw and spline	Lubricate the Z-axis spline shaft and ball screw nut after removing the old grease. The specified grease is Alvania S2 (SHOWA SHELL SEKIYU KK). (See Fig. 5-1.)
Z-axis ball spline, ball screw	Check for backlash. (If any abnormality is found, contact YAMAHA dealer.)

*1 Bolt tightening torque

Bolt size	Tightening torque (kgfcm)	Tightening torque (Nm)
M3 button head bolt	14	1.4
M4 set screw	20	2.0
M3	20	2.0
M4	46	4.5
M5	92	9.0
M6	156	15.3
M8	380	37
M10	459	45.0
M12	1310	128
M14	2090	205

Use only YAMAHA genuine bolts or JIS B 1176 hex socket head bolts (strength class: JIS B 1051 12.9).

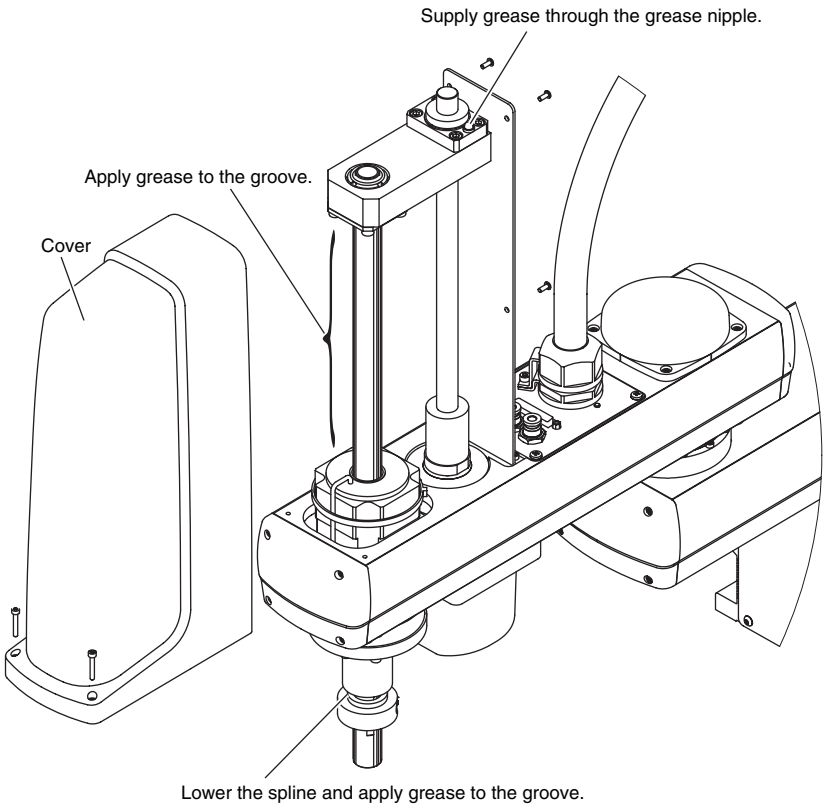

Supply grease through the grease nipple.
Apply grease to the groove.
Cover
Lower the spline and apply grease to the groove.

Fig. 5-1

(2) Inspection to be performed with the controller turned on

⚠ WARNING

- The robot controller must be installed outside the safeguard enclosure, to prevent a hazardous situation in which you or anyone enter the safeguard enclosure to inspect the controller while it is turned on.
- Bodily injury may occur from coming into contact with the fan while it is rotating.
- When removing the fan cover for inspection, first turn off the controller and make sure the fan has stopped.

1) Check that no one is inside the safeguard enclosure, and then turn on the controller.

2) Place a sign indicating the robot is being inspected, to keep others from operating the controller, programming unit or operation panel.

3) Check the following points from outside the safeguard enclosure.

Checkpoint	Procedure
• Cooling fan at rear of controller	• Check if the fan rotates normally. • Check if objects blocking the fan are located and remove if any are found. • Check for abnormal noise from the rotating fan. If abnormal noise is heard, visually check and remove the cause. If no cause is found, contact YAMAHA dealer. • Check for dust on the fan cover. Remove and clean if necessary.

(3) Adjustment and parts replacement

1) After inspection, if you notice any adjustment or parts replacement is needed, first turn off the controller and then enter the safeguard enclosure to perform the necessary work. After adjustment or replacement is finished, again review the checkpoints outlined in (1) and (2) above.

2) If repair or parts replacement is required for the robot or controller, please contact your YAMAHA dealer. This work requires specialized technical knowledge and skill, so do not attempt it by yourself.

5 Replacing the Harmonic Drive

The YK-XG series robots listed in Table 5-1 use a harmonic drive as the speed reduction gear for the X, Y and R axes. Harmonic drives need to be replaced after a specified operation time. Use the guideline explained below to determine the replacement period and replace the harmonic drive periodically. Since the YK-XG series robots listed in Table 5-1 use long-life harmonic grease, it is not necessary to replace the harmonic grease.

5-1 Replacement period

The harmonic drive replacement period is determined by the total number of turns of the wave generator used in the harmonic drive. It is recommended to replace the harmonic drive when the total number of turns has reached 8.4×10^8 (at ambient operating temperatures of 0°C to +40°C). This means that the replacement period will differ depending on the following operating conditions. If the robot operation duty ratio is high or the robot is operated in environments at higher temperatures, the harmonic drive should be replaced earlier.

Replacement period = $8.4\times10^8/(n\times60\times h\times D\times N\times\theta)$ years

where
- n : Number of axis movements per minute
- θ : Average turn per axis movement
- N : Speed reduction ratio
- h : Operation time per day
- D : Operation days per year

For example, when the robot is used under the following conditions, the replacement period for the X-axis harmonic drive of the YK500XG can be calculated as follows.

- n : 10
- θ : 0.25
- N : 80
- h : 24 hours per day
- D : 240 days per year

Replacement period = $8.4\times10^8/(n\times60\times h\times D\times N\times\theta)$
= $8.4\times10^8/(10\times60\times24\times240\times80\times0.25)$
= 12.2 years

Table 5-1 Harmonic drive speed reduction ratio

Robot model	X-axis	Y-axis	R-axis
YK500XG, YK600XG	80	80	30
YK600XGH, YK700XG, YK800XG, YK900XG, YK1000XG	80	80	50

Table 5-2 Bolt tightening torque

Bolt size	Tightening torque (kgfcm)	Tightening torque (Nm)
M3 button head bolt	14	1.4
M4 set screw	20	2.0
M3	20	2.0
M4	46	4.5
M5	92	9.0
M6	156	15.3
M8	380	37
M10	720	71

Recommended "Screw Lock": LOCTITE 262 (made by Henkel Corporation)

Use only YAMAHA genuine bolts or JIS B 1176 hex socket head bolts (strength class: JIS B 1051 12.9).

5-2 Basic replacement procedure for harmonic drive and precautions

Basic procedures and precautions for replacing the harmonic drive are described below. Before beginning the replacement work, always be sure to read these replacement procedures and caution.

⚠ WARNING

- The motor and speed reduction gear casing are extremely hot after automatic operation, so burns may occur if these are touched. Before touching these parts, turn off the controller, wait for a while and check that the temperature has cooled.
- When removing the wave generator from the motor shaft or reinstalling it back onto the motor shaft, use caution to avoid as much as possible, applying a thrust load to the motor shaft. If a load is applied, the resolver may be damaged resulting in a hazardous situation of the robot trouble.

⚠ WARNING

Precautions when handling harmonic grease, cleaning oil:

- Inflammation may occur if they get in the eyes.
  Before handling them, wear your safety goggles to ensure they will not come in contact with the eyes.
- Inflammation may occur if they come into contact with skin. Be sure to wear protective gloves to prevent contact with skin.
- Do not take orally or eat. (Eating will cause diarrhea and vomiting.)
- Hands and fingers might be cut when opening the container, so use protective gloves.
- Keep out of the reach of children.
- Do not heat them or place near an open flame since this could lead to sparks and fires.

Emergency Treatment:

- If they get in the eyes, wash liberally with pure water for about 15 minutes and consult a physician for treatment.
- If they come in contact with the skin, wash away completely with soap and water.
- If taken internally, do not induce vomiting but promptly consult a physician for treatment.

Disposing of harmonic grease, cleaning oil and the container:

- Proper disposal is compulsory under federal, state and local regulations. Take appropriate measures in compliance with legal regulations.
- Do not pressurize the empty container. Pressurizing may cause the container to rupture.
- Do not attempt to weld, heat up, drill holes or cut this container. This might cause the container to explode and the remaining materials inside it to ignite.

⚠ CAUTION

The harmonic drive service life may shorten if the grease recommended by YAMAHA is not used.

Recommended grease

Use the following harmonic drive grease.
4B No.2 (made by Harmonic Drive Systems Inc.)

⚠CAUTION

Harmonic drive

- Do not apply strong shocks or impacts to these parts such as with a hammer. Also, do not scratch, scar or dent these parts by dropping, etc. Such actions will damage the harmonic drive.
- The specified performance cannot be maintained if any part of the harmonic drive is used in a damaged state. This damage or wear may also lead to trouble with the harmonic drive.
- Since a positional shift occurs after replacing the harmonic drive, it is necessary to make absolute reset, standard coordinate setting and point data setting again.

5-2-1 YK500XG, YK600XG, YK600XGH, YK700XG, YK800XG, YK900XG, YK1000XG

The following steps describe procedures and precautions when replacing the harmonic drives of the YK500XG and YK600XG. (The illustrations show the YK500XG). For the bolt tightening torques in this work, refer to Table 5-2. Use only YAMAHA genuine bolts or JIS B 1176 hex socket head bolts (strength class: JIS B 1051 12.9).

1. X-axis

1) Prepare the following tools and items.
   - Harmonic grease 4B No.2
   - Waste cloth (rag)
   - Phillips screwdriver
   - Hex wrench set
   - Screw Lock (thread sealant)
   - Ratchet handle
   - Hexagonal socket set
   - Torque wrench (with ratchet)
   - Replacement parts (See table below.)
   - Hexagon long bit
     <YK500XG, YK600XG>
     For M6: installation diameter, 9.53 | outer diameter, 17 or less| 83 mm (approx.) at full length
     <YK600XGH to YK1000XG>
     For M5: installation diameter, 9.53 | outer diameter, 17 or less| 128mm (approx.) at full length
   - Hexagon bit
     <YK500XG, YK600XG>
     For M4: installation diameter, 6.35
     <YK600 to YK1000XG>
     For M5: installation diameter, 9.53

YK500XG, YK600XG

Replacement parts			
Parts name	Type No.	YAMAHA Parts No.	Note
Harmonic drive	SHG-25-80	KBF-M2110-000	
O-ring	① S90(JIS)	KN4-M2143-000	Top of harmonic drive
	② Rubber wire diameter 1.78mm Ring inner diameter 66.4mm	90990-17J030	Base (robot pedestal)
	③ Rubber wire diameter 1.30mm Ring inner diameter 66.50mm	KN5-M257L-000	Supplied with harmonic drive

YK600XGH, YK700XG, YK800XG, YK900XG, YK1000XG

Replacement parts			
Parts name	Type No.	YAMAHA Parts No.	Note
Harmonic drive	SHG-32-80	KBF-M2110-000	
O-ring	① S511(JIS)	KN5-M2159-000	Top of harmonic drive
	② Rubber wire diameter 1.50mm Ring inner diameter 82.00mm	90990-17J035	Base (robot pedestal)
	③ Rubber wire diameter 1.50mm Ring inner diameter 87.50mm	KN5-M2199-000	Supplied with harmonic drive

2) Turn off the controller.

3) Place a sign indicating that the robot is being inspected, to keep others from operating the controller switch.

4) Enter the safeguard enclosure.

5) Remove the base front and rear covers. (See Fig. 5-2.)

6) Unplug the connectors on the X-axis motor power wire XM and resolver wire XP in the base. Also disconnect the X-axis motor ring-tongue terminal.

⚠CAUTION

Carefully remove the motor not to pinch fingers between the motor and the base. An O-ring ② is placed between the motor mating end face and the base. Replace this O-ring with a new one. (See Fig. 5-4 and Fig. 5-6.)
On the YK600XGH and YK700XG to YK1000XG, an O-ring is placed between the motor flange end face and the base.

7) Remove the bolts securing the motor by using a hexagon long bit and ratchet handle, while holding the motor not to let it drop (see Fig 5-3). Items in parentheses ( ) apply to the YK600XGH, and YK700XG to YK1000XG.

8) Pull the motor out of the base while turning the X-axis arm.

9) Remove the wave generator from the motor shaft.
The wave generator is secured with a set screw (1 piece) and keyway (see Fig. 5-6). A spacer and bolts need to be removed for YK600XGH and YK700XG to YK1000XG.

⚠CAUTION

A spacer is inserted between the wave generator and the motor, so be careful not to lose it. No spacer is used there for the YK600XGH, and YK700XG to YK1000XG.

⚠WARNING

- When you remove the X-axis arm installation bolts in the next step, the X-axis arm may come off causing a hazardous situation. Be especially careful to keep the arm from falling when a heavy tool is attached to the arm tip. (See Fig. 5-4.)
- Removing the X-axis arm is dangerous for just one person. Always use two or more people, or remove the Y-axis arm in advance. Refer to "2. Y-axis" of "5-2-1" for removing the Y-axis arm.

10) Remove the X-axis arm installation bolts by using a hexagon bit and ratchet handle. (See Fig. 5-4).

11) Remove the X-axis arm and place it where it will not obstruct the work.

12) Remove the bolts securing the X-axis harmonic drive and also remove the panhead bolt along with the nut. (See Fig. 5-5.)

13) Remove the X-axis harmonic drive from the X-axis arm.

⚠CAUTION

An O-ring ① is fitted to the X-axis arm. Replace this O-ring with a new one.

14) Fit a new O-ring ① coated with harmonic grease into the O-ring groove of the X-axis arm (See Fig. 5-5.). Grease to the O-ring is to prevent the O-ring from coming off, so a small amount is enough.
Apply small amounts of "Screw Lock" to the bolts you removed earlier and tighten them to secure the new harmonic drive to the X-axis arm. Also return the panhead bolt and nut to the original position and secure them (See Fig. 5-5.). Apply small amounts of "Screw Lock" to the panhead bolt. See 1-2 in 3-4-1-1 for the panhead bolt tightening and tighten the bolt to the specified torque.

⚠CAUTION

Do not allow the O-ring to get caught out of the groove during reassembly. A problem will occur if the robot is operated with the O-ring left caught out of the groove.

15) Apply harmonic grease to the new wave generator and flexible spline.
See Fig. 5-7 for applying grease properly.

16) Fit a new O-ring ③ coated with harmonic grease into the O-ring groove of the harmonic drive. Apply small amount of "Screw Lock" to the positioning bolts, then fix the harmonic drive to the base with 16 pieces of bolt by using hexagon bit and torque wrench (see Fig. 5-5 and Fig. 5-7). Tighten the bolts to the specified torque.

⚠CAUTION

Do not allow the O-ring to get caught out of the groove during reassembly. A problem will occur if the robot is operated with the O-ring left caught out of the groove.

17) Fit the spacer and wave generator onto the motor shaft, and fully insert them against the motor. Then, apply small amounts of "Screw Lock" to the set screw (1 piece) you removed earlier and tighten it to secure the wave generator onto the motor shaft (see Fig. 5-6). For 600XGH and YK700XG to YK1000XG, the wave generator need to be fixed with M5 bolts and spacers prior to this step.

18) Place a new O-ring ② in the cylindrical section of the base and push the O-ring to the top end face. (See Fig. 5-4.)

⚠CAUTION

Do not allow the O-ring to get caught out of the groove during reassembly. A problem will occur if the robot is operated with the O-ring left caught out of the groove.

19) Push the X-axis motor into the base while moving the X-axis arm by hand. Push the X-axis motor into the base while moving the X-axis arm by hand. Uniformly tighten the four bolts by using the hexagon long bit and torque wrench, while moving the X-axis arm by hand slowly left and right through 45°. If any jamming or catching is felt while moving the axis at this time, then reassemble from the beginning. (See Fig. 5-3.)

20) Reattach the connectors on the X-axis motor power wire XM and resolver wire XP. (See Fig. 5-2.) Also reattach the X-axis motor ring-tongue terminal.

21) Reattach the base (robot pedestal) front and rear covers.

22) Go outside the safeguard enclosure.

23) Check that no one is inside the safeguard enclosure, and then turn on the controller.

⚠CAUTION

After the Harmonic drive is replaced, an absolute reset must be performed, and the standard coordinate and point data must be reset. Refer to "Chapter 4 Adjustment" to adjust it.

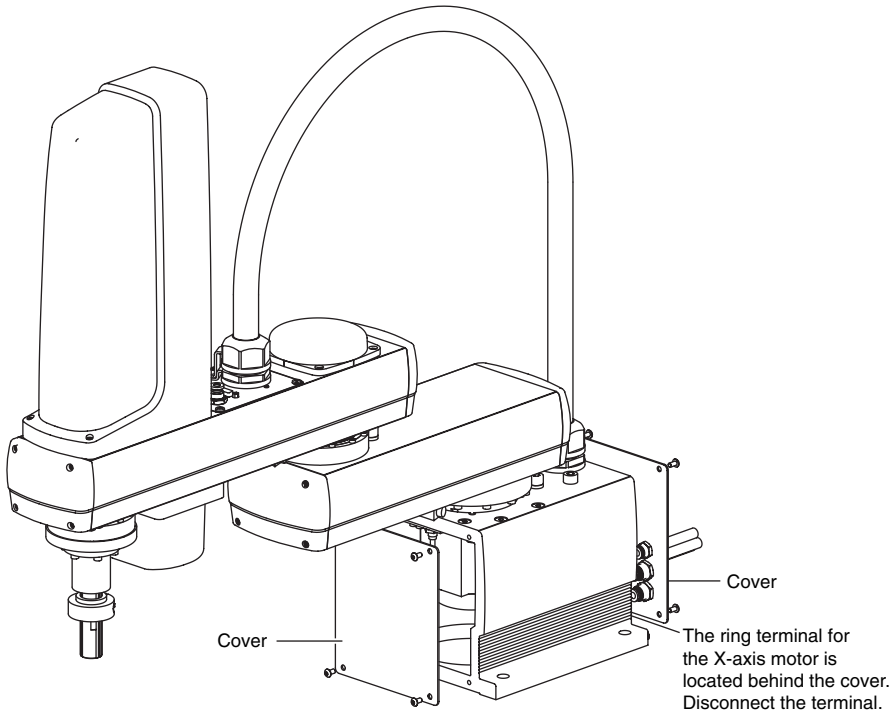


Fig. 5-2

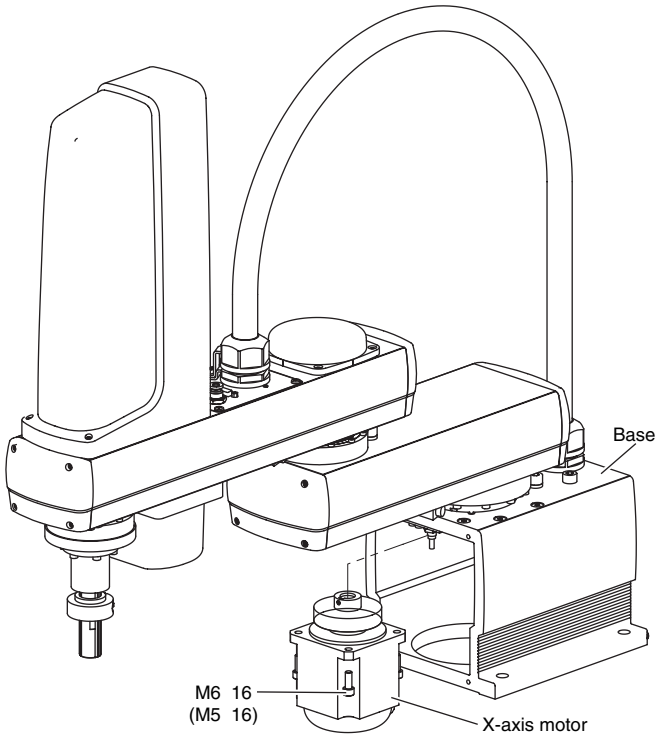
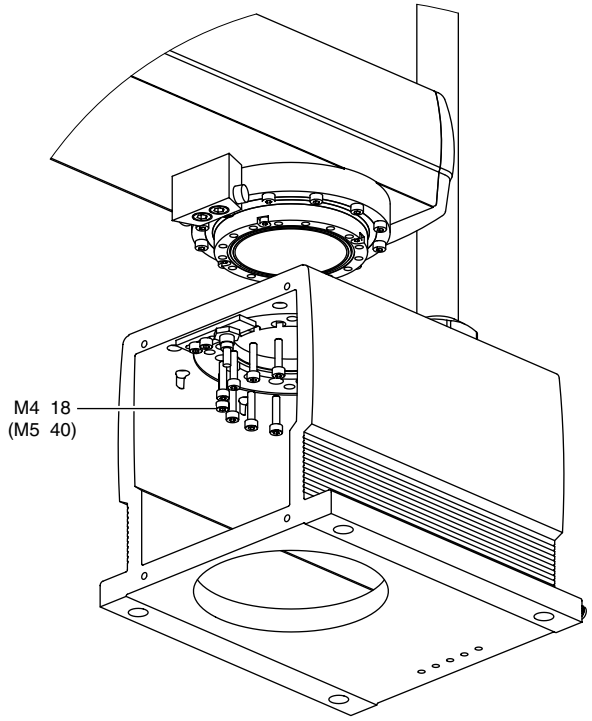
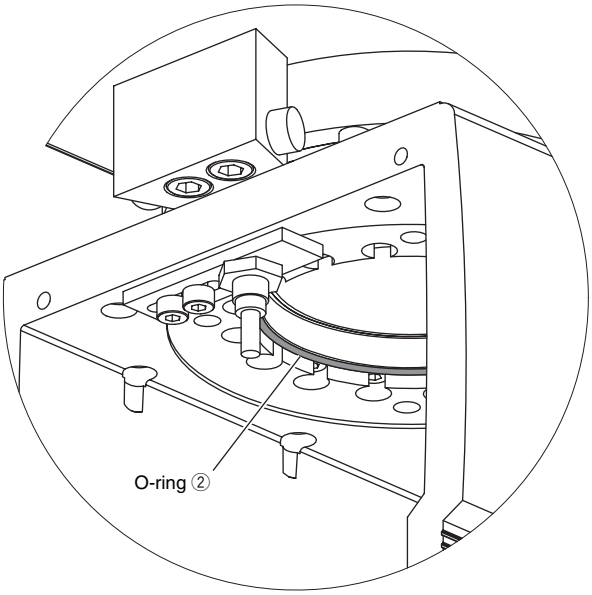
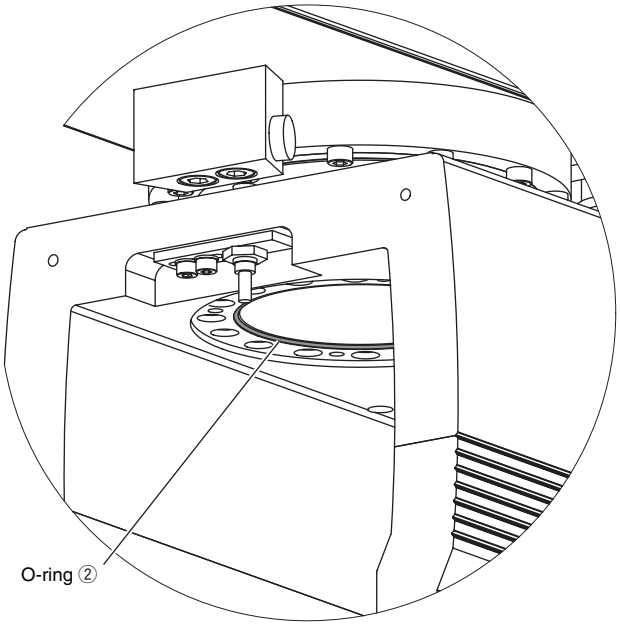


Fig. 5-3







YK500XG, YK600XG

YK600XGH, YK700XG, YK800XG, YK900XG, YK1000XG

Fig. 5-4

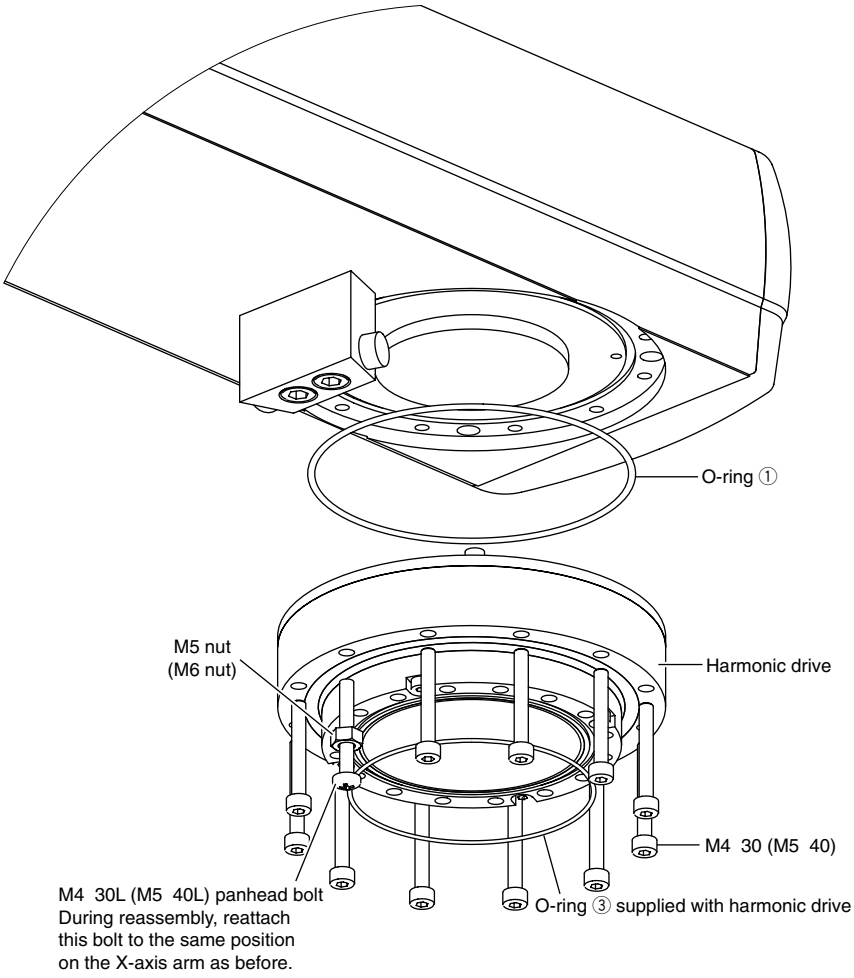
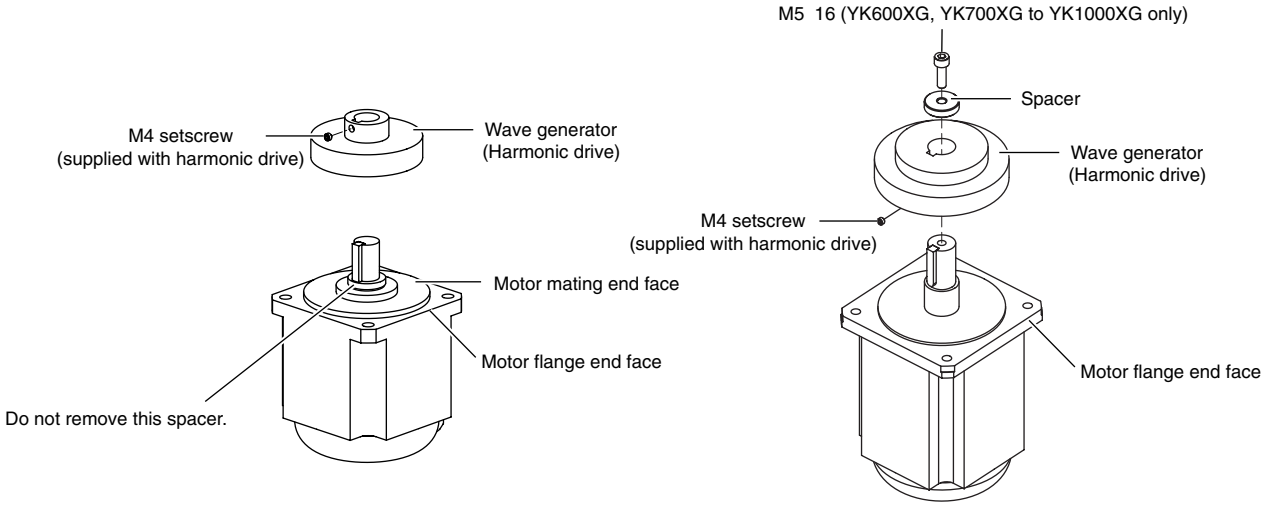


Fig. 5-5



YK500XG, YK600XG

YK600XGH, YK700XG, YK800XG, YK900XG, YK1000XG

Fig. 5-6

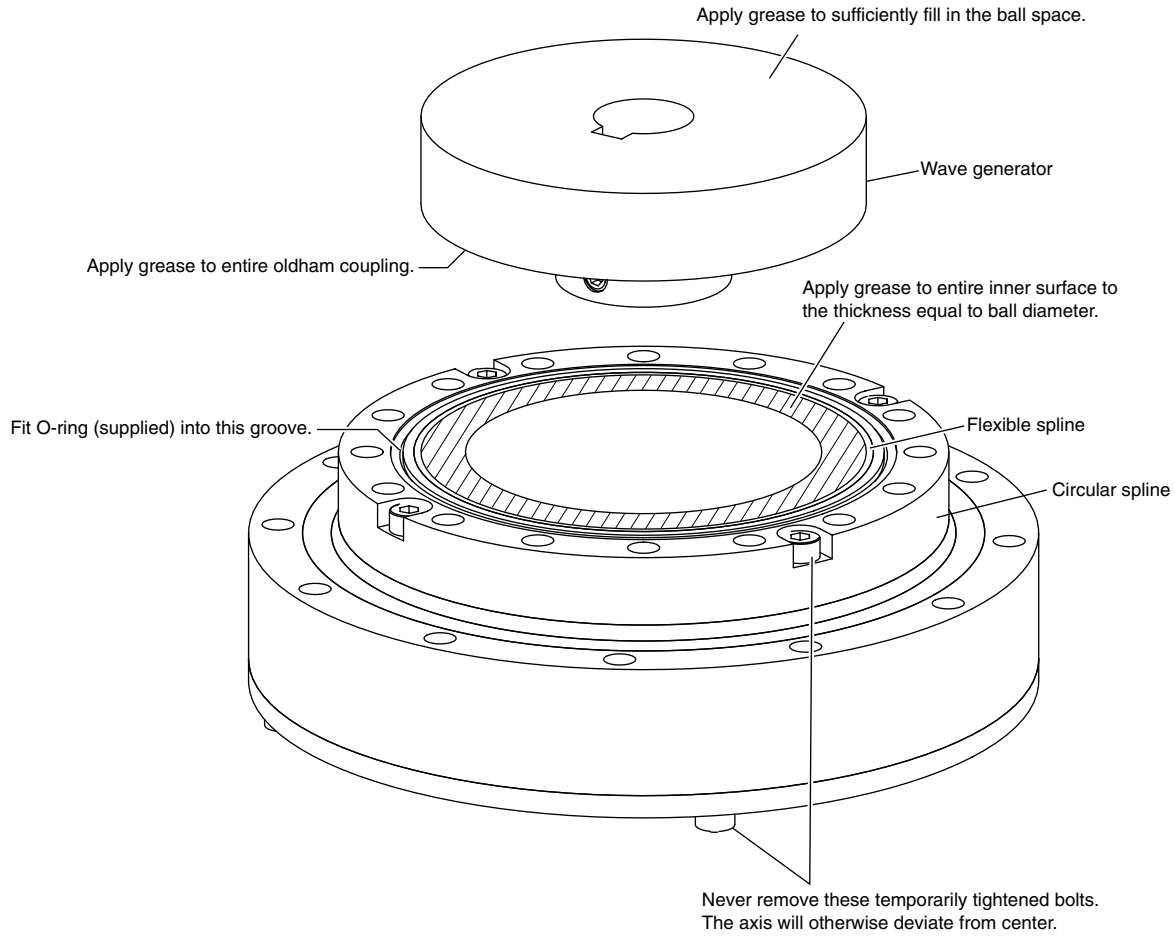

Apply grease to sufficiently fill in the ball space.
Wave generator
Apply grease to entire oldham coupling.
Apply grease to entire inner surface to
the thickness equal to ball diameter.
Fit O-ring (supplied) into this groove.
Flexible spline
Circular spline
Never remove these temporarily tightened bolts.
The axis will otherwise deviate from center.

Fig. 5-7

2. Y-axis

1) Prepare the following tools and items.
   - Harmonic grease 4B No.2
   - Waste cloth (rag)
   - Phillips screwdriver
   - Hex wrench set
   - Screw Lock (thread sealant)
   - Torque wrench
   - Replacement parts (See table below.)

YK500XG, YK600XG

Replacement parts			
Parts name	Type No.	YAMAHA Parts No.	Note
Harmonic drive	SHG-20-80	KBF-M2510-000	
O-ring	① Rubber wire diameter 1.78mm Ring inner diameter 72.75mm	KN4-M257K-000	Lower part of harmonic drive
	② Rubber wire diameter 1.50mm Ring inner diameter 49.00mm	KN3-M2143-000	For motor
	③ Rubber wire diameter 0.99mm Ring inner diameter 53.28mm	KN3-M2144-000	Supplied with harmonic drive

YK600XGH, YK700XG, YK800XG, YK900XG, YK1000XG

Replacement parts			
Parts name	Type No.	YAMAHA Parts No.	Note
Harmonic drive	SHG-25-80	KBP-M2510-000	
O-ring	① S90(JIS)	KN4-M2143-000	Lower part of harmonic drive
	② Rubber wire diameter 1.78mm Ring inner diameter 66.40mm	90990-17J030	For motor
	③ Rubber wire diameter 1.3mm Ring inner diameter 66.50mm	KN5-M257L-000	Supplied with harmonic drive

2) Turn off the controller.

3) Place a sign indicating that the robot is being inspected, to keep others from operating the controller switch.

4) Enter the safeguard enclosure.

5) Remove the cover. (See Fig. 5-8.)

6) Unplug the connectors on the Y-axis motor power wire YM and resolver wire YP in the Y-axis arm. Also disconnect the Y-axis motor ring-tongue terminal.

7) Remove the bolts securing the Y-axis motor, and slowly pull out the Y-axis motor while turning the Y-axis joint. (See Fig. 5-9.)
   Items in parentheses ( ) apply to the YK600XGH and YK700XG to YK1000XG.

⚠CAUTION

An O-ring ② is fitted to the motor. Replace this O-ring with a new one. (See Fig. 5-12.)

8) Remove the wave generator from the motor shaft. The wave generator is secured with a set screw (1 piece) and keyway. (See Fig. 5-12.)

⚠WARNING

When you remove the Y-axis arm installation bolts in the next step, the Y-axis arm may come off causing a hazardous situation. Be especially careful to keep the arm from falling when a heavy tool is attached to the arm tip.
(See Fig. 5-10.)

9) Remove the Y-axis arm installation bolts. (See Fig. 5-10.)

10) Remove the Y-axis arm and place it where it will not obstruct the work.

⚠CAUTION

An O-ring ③ is fitted to the upper surface of the harmonic drive, so be careful not to let it drop into the peripheral unit. (See Fig. 5-11.)

11) Remove the bolts securing the Y-axis harmonic drive and also remove the panhead bolt along with the nut. (See Fig. 5-11.)

12) Remove the Y-axis harmonic drive from the top of the X-axis arm.

⚠CAUTION

An O-ring ① is fitted to the upper surface of the X-axis arm. Replace this O-ring with a new one.

13) Fit a new O-ring ① coated with harmonic grease into the O-ring groove of the X-axis arm. (See Fig. 5-11.)

14) Place the new harmonic drive on the X-axis arm and secure it with the bolts you removed earlier. At this point, apply small amounts of "Screw Lock" to those bolts and uniformly tighten them. Also return the panhead bolt and nut to the original position and secure them. Apply small amounts of "Screw Lock" to the panhead bolt. See 2-2 in 3-4-1-1 for the panhead bolt tightening and tighten the bolt to the specified torque.

⚠CAUTION

Do not allow the O-ring to get caught out of the groove during reassembly. A problem will occur if the robot is operated with the O-ring left caught out of the groove.

15) Fit a new O-ring ③ coated with harmonic grease into the O-ring groove of the harmonic drive. (Fig. 5-11.)

16) Secure the Y-axis arm to the harmonic drive with the bolts you removed earlier. At this time keep the Y-axis arm level by two people so as not to apply a moment to the Y-axis. One person supports the tip of the Y-axis arm. The other person secures the Y-axis arm.
Apply small amounts of "Screw Lock" to the 16 bolts and tighten them uniformly to secure the Y-axis arm. (See Fig. 5-10.) Tighten the bolts to the specified torque.

⚠CAUTION

Do not allow the O-ring to get caught out of the groove during reassembly. A problem will occur if the robot is operated with the O-ring left caught out of the groove.

17) Apply harmonic grease to the new wave generator and flexible spline.
See Fig. 5-7 for applying grease properly.

18) Fit the wave generator onto the motor shaft, and fully insert it against the motor. Then, apply small amounts of "Screw Lock" to the set screw (1 piece) you removed earlier and tighten it to secure the wave generator (See Fig. 5-12.). On the YK600XGH and YK700XG to YK1000XG, do not forget to insert a spacer.

19) Fit a new O-ring ② to the motor and place the motor in the Y-axis arm while turning the Y-axis joint. Then tighten the bolts you removed earlier to temporarily secure the motor to the Y-axis arm. (See Fig. 5-9.)
On the YK600XGH and YK700XG to YK1000XG, fit the new O-ring ② into the groove in the Y-axis arm. (See Fig. 5-12.)

⚠CAUTION

Do not allow the O-ring to get caught out of the groove during reassembly. A problem will occur if the robot is operated with the O-ring left caught out of groove.

20) Uniformly tighten the four bolts temporarily fastened in the previous step while turning the Y-axis joint. If any jamming or catching is felt at this time, then reassemble from the beginning.

21) Reattach the connectors on the Y-axis motor power wire YM and resolver wire YP. (See Fig. 5-8.) Also reattach the Y-axis motor ring-tongue terminal.

22) Reattach the cover.

23) Go outside the safeguard enclosure.

24) Check that no one is inside the safeguard enclosure, and then turn on the controller.

⚠CAUTION

After the Harmonic drive is replaced, an absolute reset must be performed, and the standard coordinate and point data must be reset. Refer to "Chapter 4 Adjustment" to adjust it.

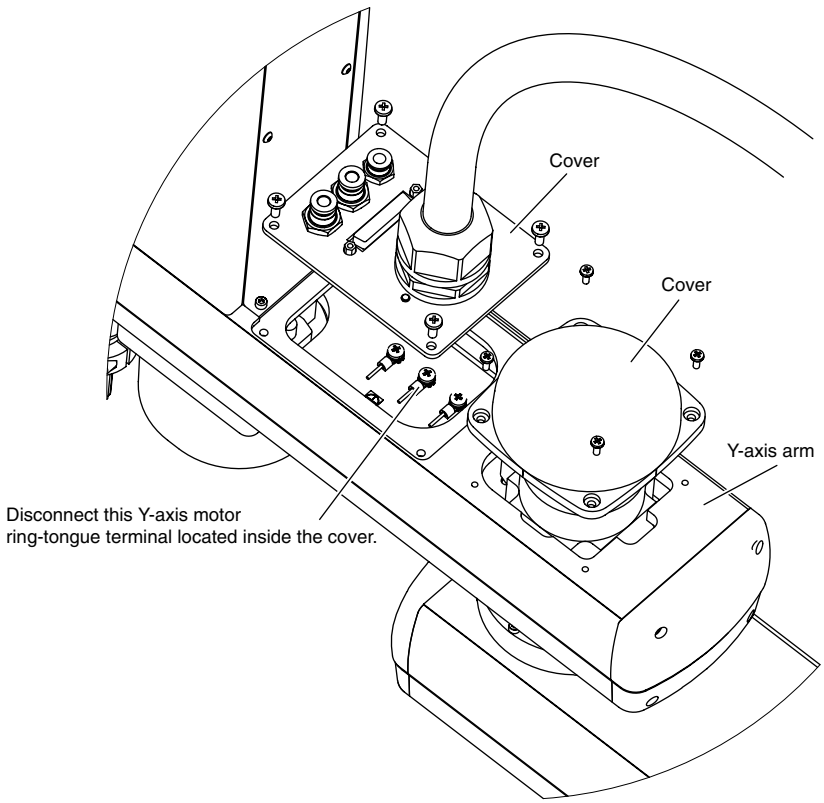

Cover
Cover
Y-axis arm
Disconnect this Y-axis motor
ring-tongue terminal located inside the cover.

Fig. 5-8

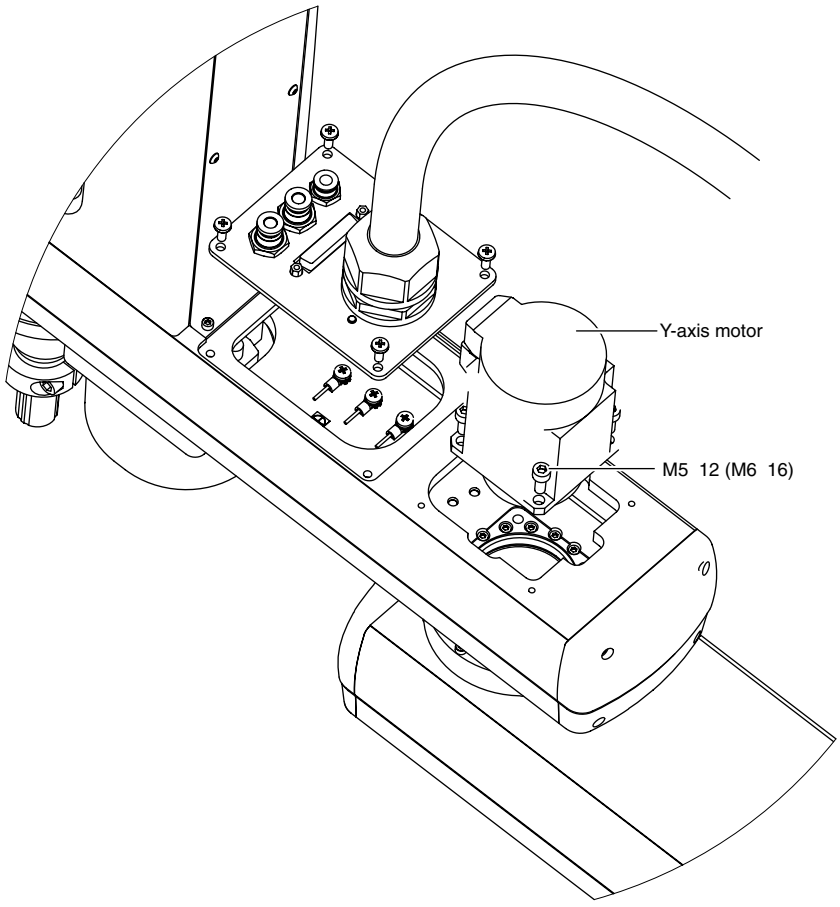

Y-axis motor
M5 12 (M6 16)

Fig. 5-9

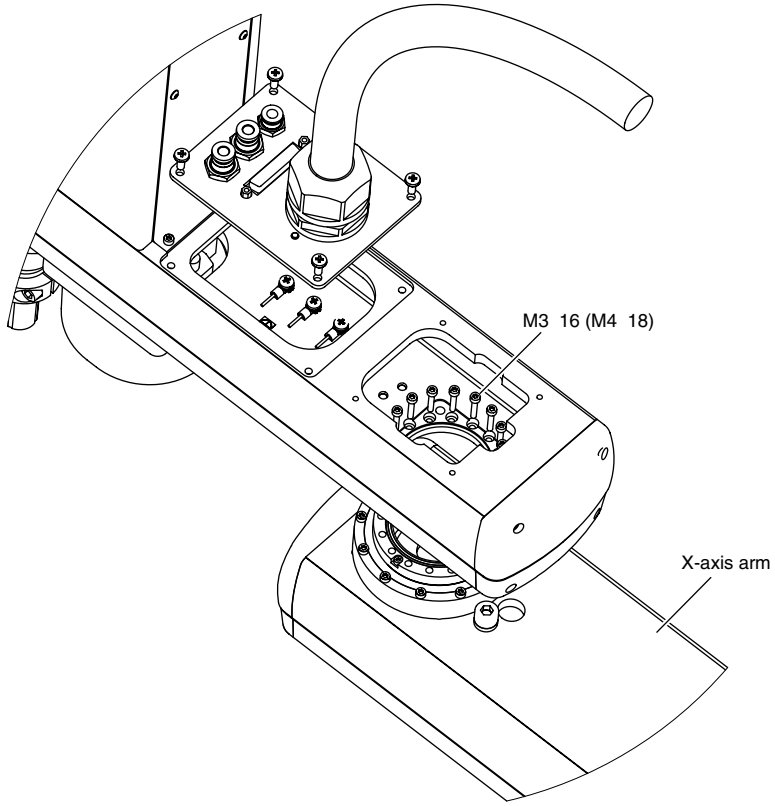


Fig. 5-10

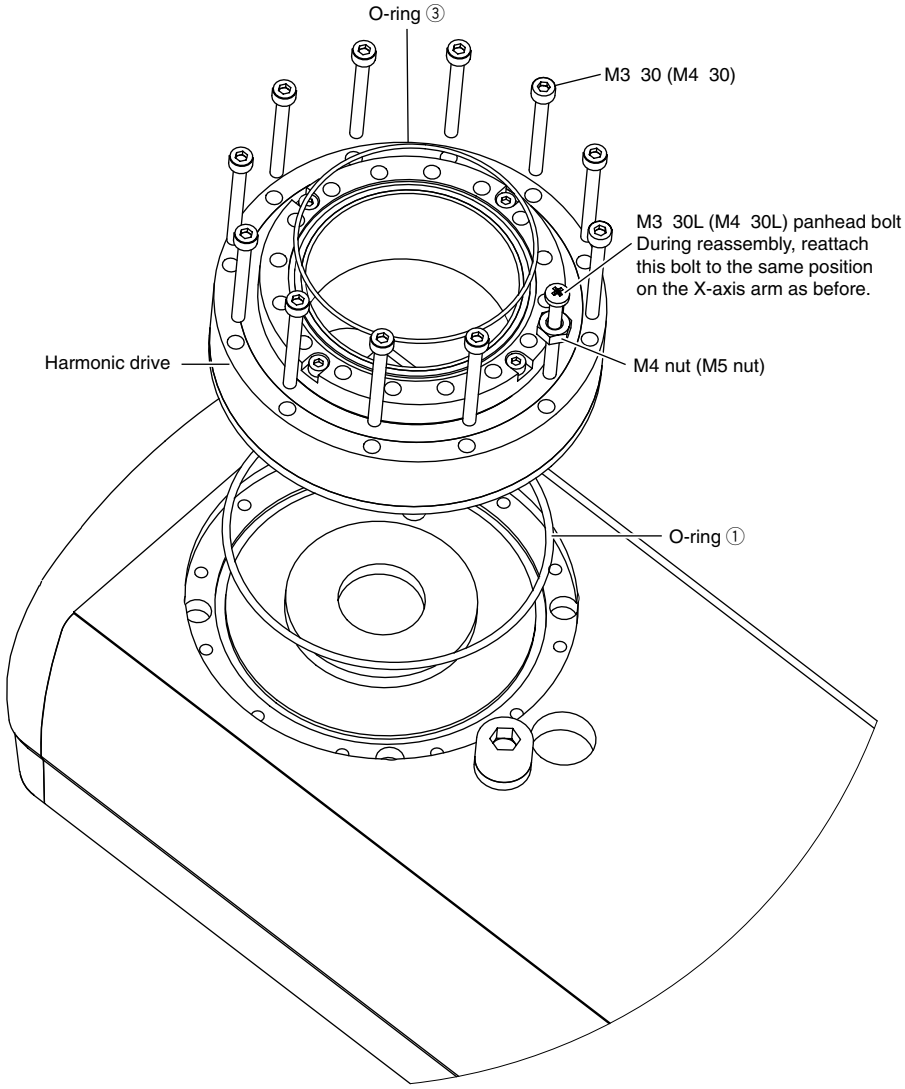
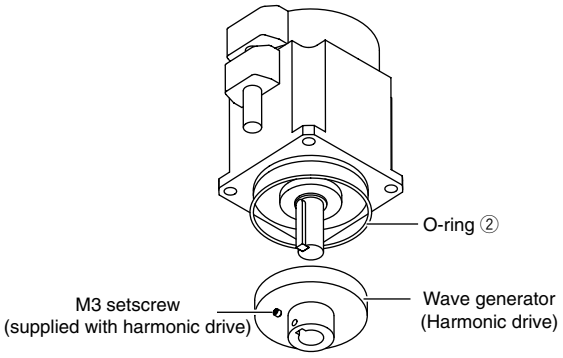
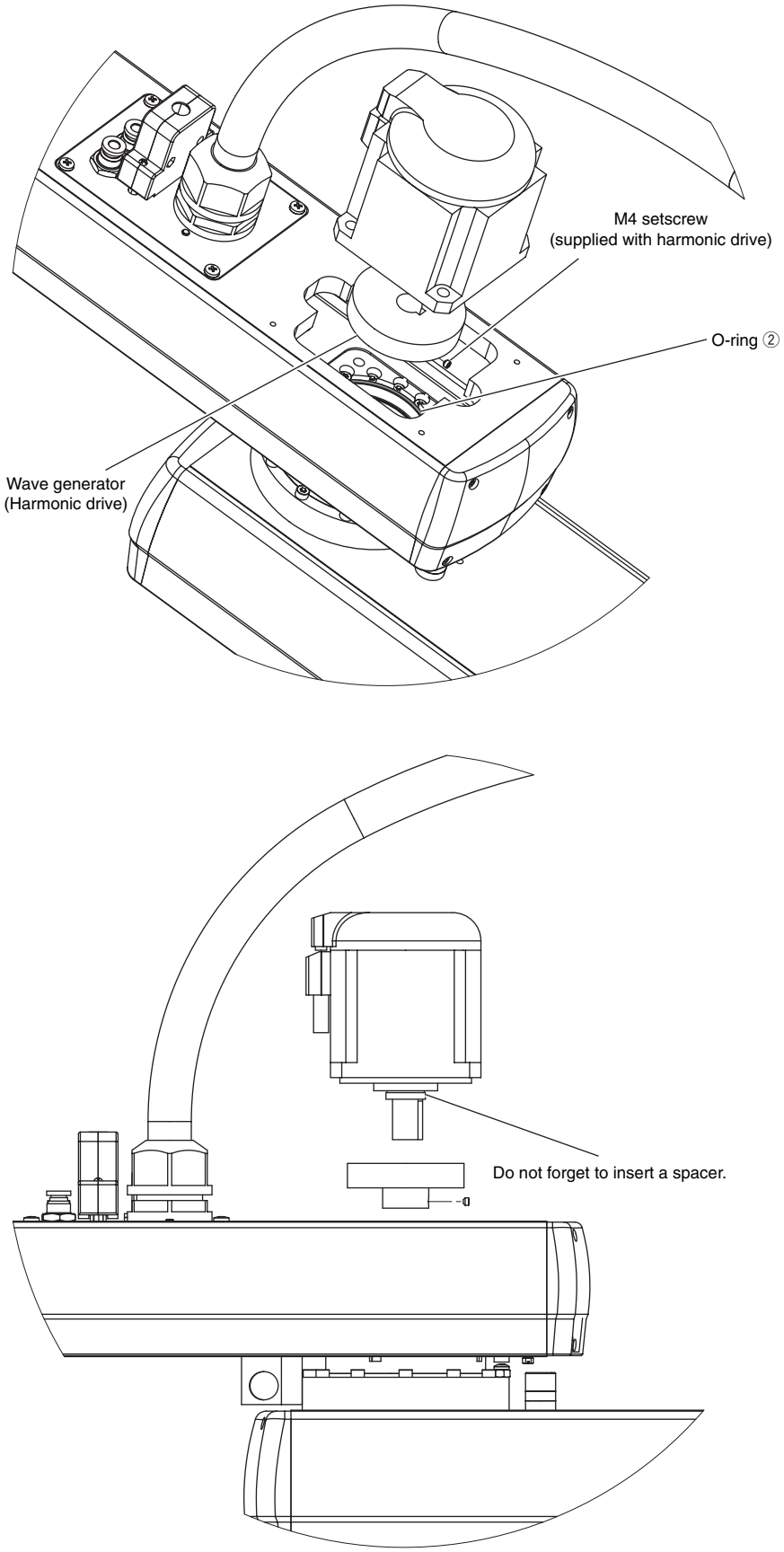


Fig. 5-11



YK500XG, YK600XG

Fig. 5-12



YK600XGH, YK700XG, YK800XG, YK900XG, YK1000XG

Fig. 5-12

3. R-axis

1) Prepare the following tools and items.
   - Harmonic grease 4B No.2
   - Waste cloth (rag)
   - Phillips screwdriver
   - Hex wrench set
   - Screw Lock (thread sealant)
   - Torque wrench
   - Hook wrench
   - Replacement parts (See table below.)

YK500XG, YK600XG

Replacement parts			
Parts name	Type No.	YAMAHA Parts No.	Note
Harmonic drive	SHF-17-30	KBF-M1821-000	
O-ring	① Rubber wire diameter 1.78mm Ring inner diameter 63.22mm	KN4-M1896-000	Lower part of harmonic drive
	② Rubber wire diameter 0.80mm Ring inner diameter 45.40mm	KN3-M257L-000	Supplied with harmonic drive
	③ Rubber wire diameter 1.00mm Ring inner diameter 35.3mm	90990-17J031	Spline nut
	④ Rubber wire diameter 1.00mm Ring inner diameter 46.00mm	90990-17J032	Y-axis arm
	⑤ Rubber wire diameter 0.60mm Ring inner diameter 22.00mm	90990-17J033	Wave generator
Edge seal	V-25A (N+C)	KBF-M1886-000	FORSHEDA

YK600XGH, YK700XG, YK800XG, YK900XG, YK1000XG

Replacement parts			
Parts name	Type No.	YAMAHA Parts No.	Note
Harmonic drive	SHF-20-50	KBP-M1821-000	
O-ring	① S71(JIS)	KN3-M2159-000	Lower part of harmonic drive
	② Rubber wire diameter 0.99mm Ring inner diameter 53.28mm	KN3-M2144-000	Supplied with harmonic drive
	③ Rubber wire diameter 1.00mm Ring inner diameter 43.00mm	90990-17J036	Spline nut
	④ Rubber wire diameter 1.30mm Ring inner diameter 53.00mm	90990-17J038	Y-axis arm
	⑤ Rubber wire diameter 0.5mm Ring inner diameter 28.00mm	90990-17J037	Wave generator
Edge seal	V-28A (N+C)	KBP-M1886-000	FORSHEDA

2) Turn off the controller.

3) Place a sign indicating that the robot is being inspected, to keep others from operating the controller switch.

4) Enter the safeguard enclosure.

5) Remove the cover. (See Fig. 5-13.)
   Unplug the connectors on the R-axis motor power wire RM and resolver wire RP in the Y-axis arm. Also disconnect the R-axis motor ring-tongue terminal.

⚠ WARNING

The Z-axis will slide down when the bearing mounting bolts are removed in the next step, causing a hazardous situation. Prop the Z-axis with a support stand before loosening these bolts. (See Fig. 5-14.)

6) Remove the bolts securing the bearing to the upper end of the spline and remove the spline and bearing from the holder. (See Fig. 5-14.)

7) Fit the spanner or wrench to the flat surfaces at the bottom of the spline to grip it, and loosen and remove the U-nut on top of the spline with the hook spanner. Then remove the bearing and bearing mount plate. (See Figs. 5-15 and 5-16.)
At this point, be careful to keep the spline shaft from coming off the spline nut.

8) Remove the bolts securing the spline nut and remove the spline nut. (See Fig. 5-16.)

⚠CAUTION

An O-ring ③ is fitted to the shaft. Replace this O-ring with a new one. Also replace the V-ring with a new one. Do not remove the sleeve. (See Fig. 5-16.)

9) Remove the bolts securing the R-axis motor and pull out the R-axis motor while turning the R-axis. (See Fig. 5-17.)

⚠CAUTION

An O-ring ④ is placed between the R-axis motor flange and the Y-axis arm. Replace this O-ring with a new one. (See Fig. 5-17.)

10) Loosen the two setscrews for the wave generator.
Pull the wave generator out of the R-axis motor shaft. (See Fig. 5-20.)

⚠CAUTION

An O-ring ⑤ is placed between the R-axis motor shaft and the wave generator. Replace this O-ring with a new one. (See Fig. 5-20.)

11) Remove the bolts securing the harmonic drive and remove the harmonic drive. (See Fig. 5-18.)

⚠CAUTION

An O-ring ② is fitted to the harmonic drive. Replace this O-ring with a new one. (See Fig. 5-18.)

12) Remove the shaft mounting bolts from the harmonic drive and also remove the panhead bolt along with the nut. Then remove the shaft.
On the YK600XGH and YK700XG to YK1000XG, remove the dog and bolt. (See Fig. 5-19 (b).)

⚠CAUTION

An O-ring ① is placed between the harmonic drive and shaft. Replace this O-ring with a new one. (See Fig. 5-19 (a) (b).)

13) Apply the harmonic grease to the new wave generator. See Fig. 5-21 for applying the grease.

14) Fit the O-ring ⑤ to the inner side of the new wave generator. Insert the wave generator into the inner end of the R-axis motor shaft and secure it with the two setscrews. (See Fig. 5-20.)

15) Apply harmonic grease to the circular spline.
See Fig. 5-21 for applying grease properly.

16) Fit a new O-ring ① coated with harmonic grease into the groove of the shaft. Apply small amounts of "Screw Lock" to the bolts you removed earlier and tighten them to secure the new harmonic drive. Also return the panhead bolt and nut to the original position and secure them. Apply small amounts of "Screw Lock" to the panhead bolt. The panhead bolt tightening torque should be 90cNm (9kgfcm). On the YK600XGH and YK700XG to YK1000XG, also apply "Screw Lock" to the dog mounting bolt and tighten it to a torque of 2.0Nm (20kgfcm). (See Fig. 5-19 (b).)

⚠CAUTION

Do not allow the O-ring to get caught out of the groove during reassembly. A problem will occur if the robot is operated with the O-ring left caught out of groove.

17) Fit the O-ring ② coated with harmonic grease into the O-ring groove of the new harmonic drive. (See Fig. 5-18.)
Apply small amounts of "Screw Lock" to the bolts you removed earlier and tighten them to secure the new harmonic drive to the Y-axis arm from the top of the Y-axis arm. (See Fig. 5-18.)

⚠CAUTION

Do not allow the O-ring to get caught out of the groove during reassembly. A problem will occur if the robot is operated with the O-ring left caught out of groove.

18) Fit the new O-ring ④ coated with harmonic grease into the O-ring groove of the Y-axis arm.
Insert the R-axis motor into the Y-axis arm while turning the R-axis. Then tighten the bolts to secure the R-axis motor while turning the R-axis. (See Fig. 5-17.)

⚠CAUTION

Do not allow the O-ring to get caught out of the groove during reassembly. A problem will occur if the robot is operated with the O-ring left caught out of groove.

19) Fit the new O-ring ③ coated with harmonic grease into the groove at the bottom of the shaft. Attach a new V-ring to the top of the sleeve and secure the spline nut to the shaft with the bolts you removed earlier. (See Fig. 5-16.)

⚠CAUTION

Do not allow the O-ring to get caught out of the groove during reassembly. A problem will occur if the robot is operated with the O-ring left caught out of groove.

20) Insert the bearing mount plate and bearing onto the spline from the top, and tighten the U-nut to secure the bearing. (Utilize the flat surfaces when tightening the U-nut like you did to loosen it.) On the YK600XGH and YK700XG to YK1000XG, do not forget to insert a spacer. (See Fig. 5-15.)

21) Insert the spline and bearing through the holder and secure them with the bolts you removed earlier. (See Fig. 5-14.)

22) Reconnect the R-axis motor power wire RM and resolver wire RP.
Also reconnect the R-axis motor ring-tongue terminal.

23) Reattach the cover.

24) Go outside the safeguard enclosure.

25) Check that no one is inside the safeguard enclosure, and then turn on the controller.

⚠CAUTION

After the Harmonic drive is replaced, the absolute reset must be performed, and the point data must be reset. Refer to "Chapter 4 Adjustment" to adjust it.

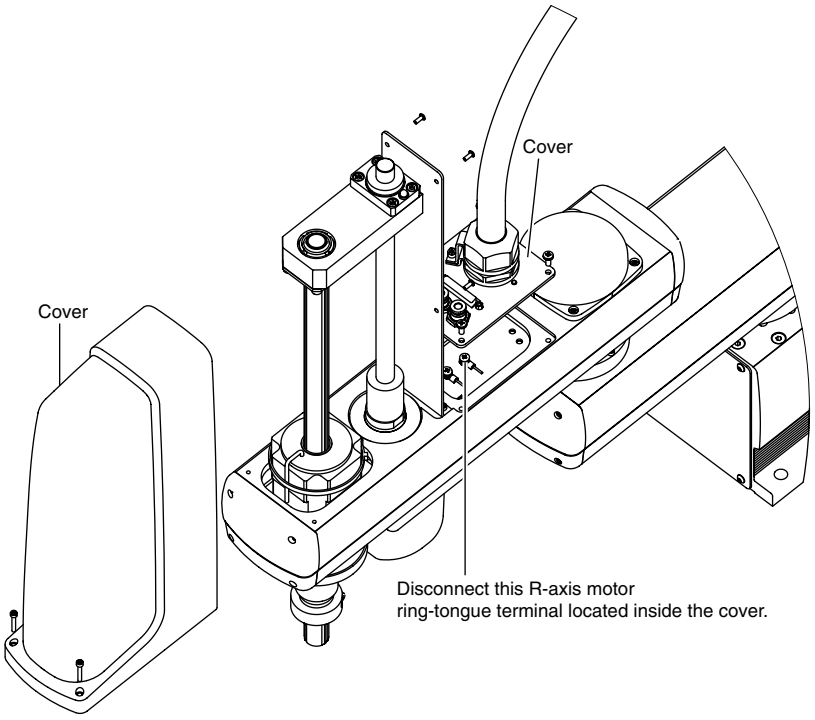


Fig. 5-13

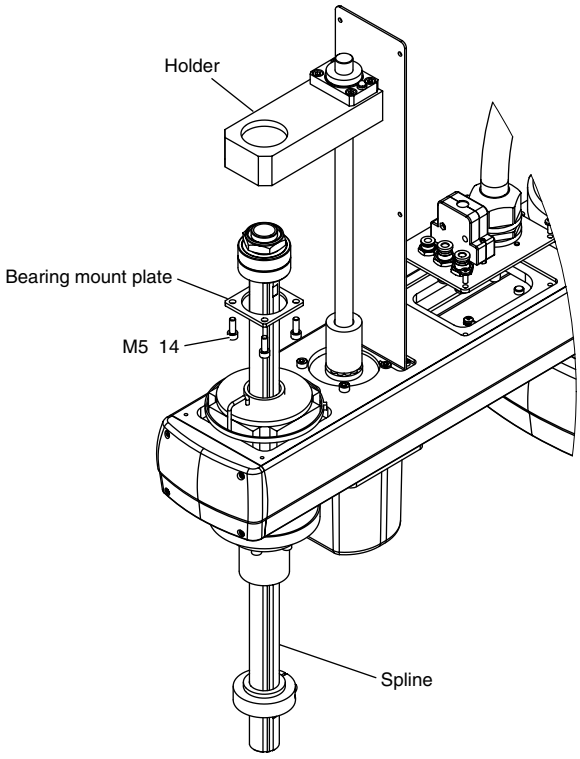
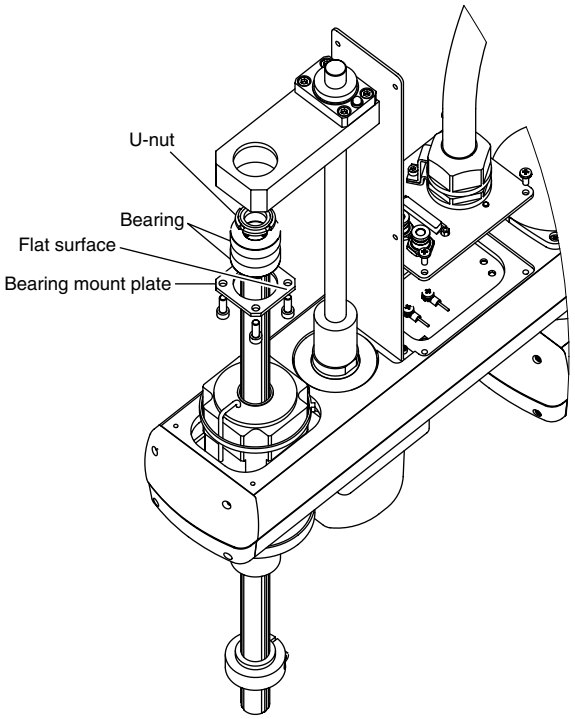
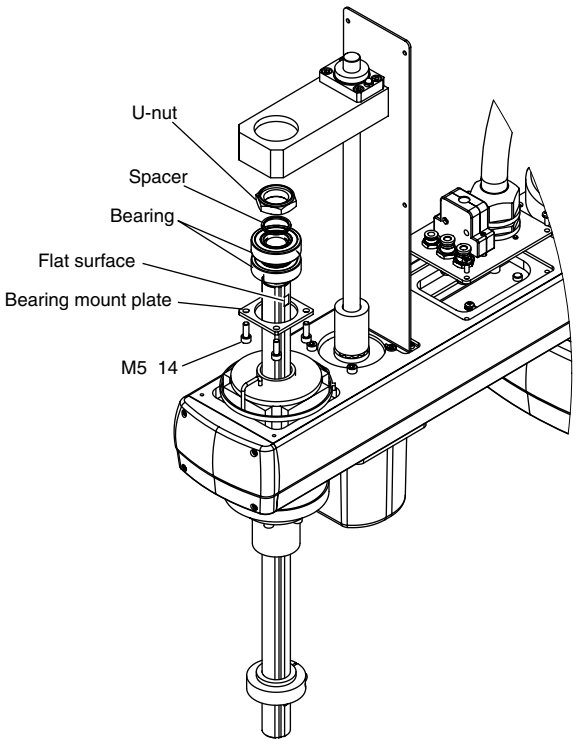


Fig. 5-14



YK500XG, YK600XG



YK600XGH, YK700XG, YK800XG, YK900XG, YK1000XG

Fig. 5-15

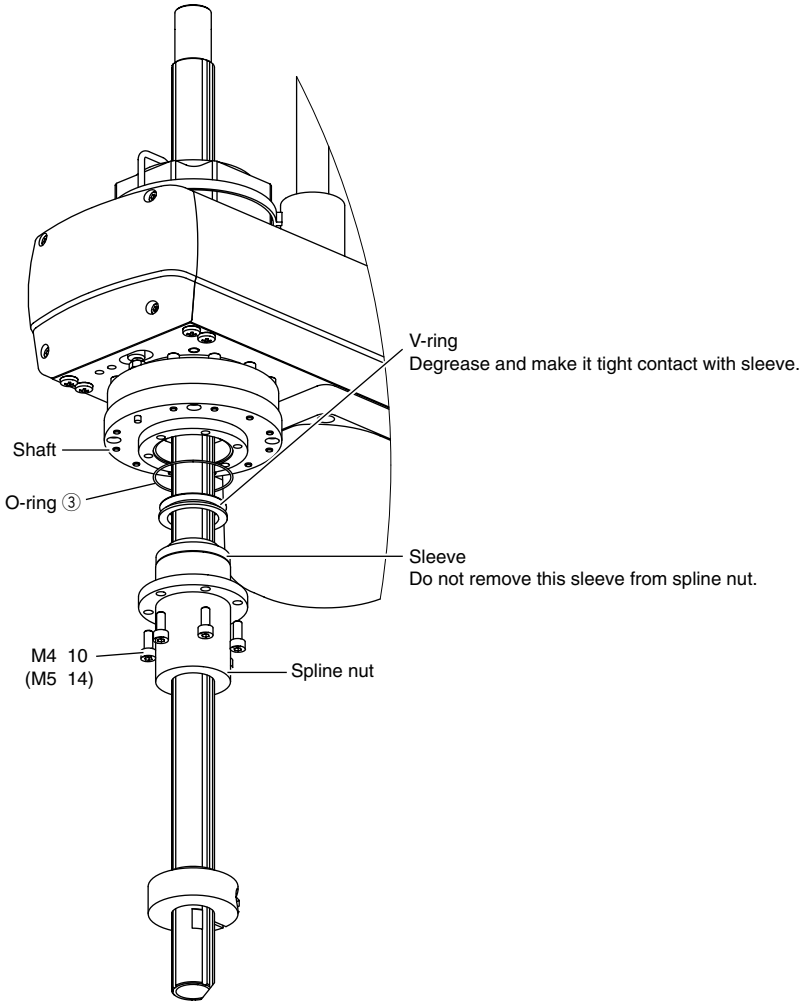


Fig. 5-16

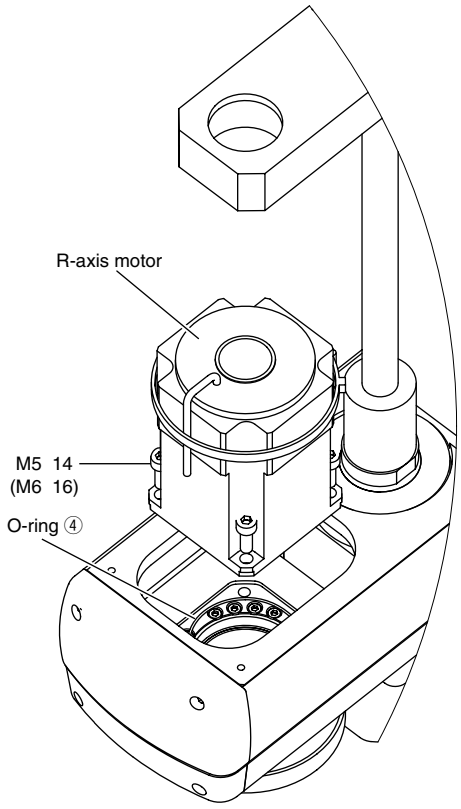


Fig. 5-17

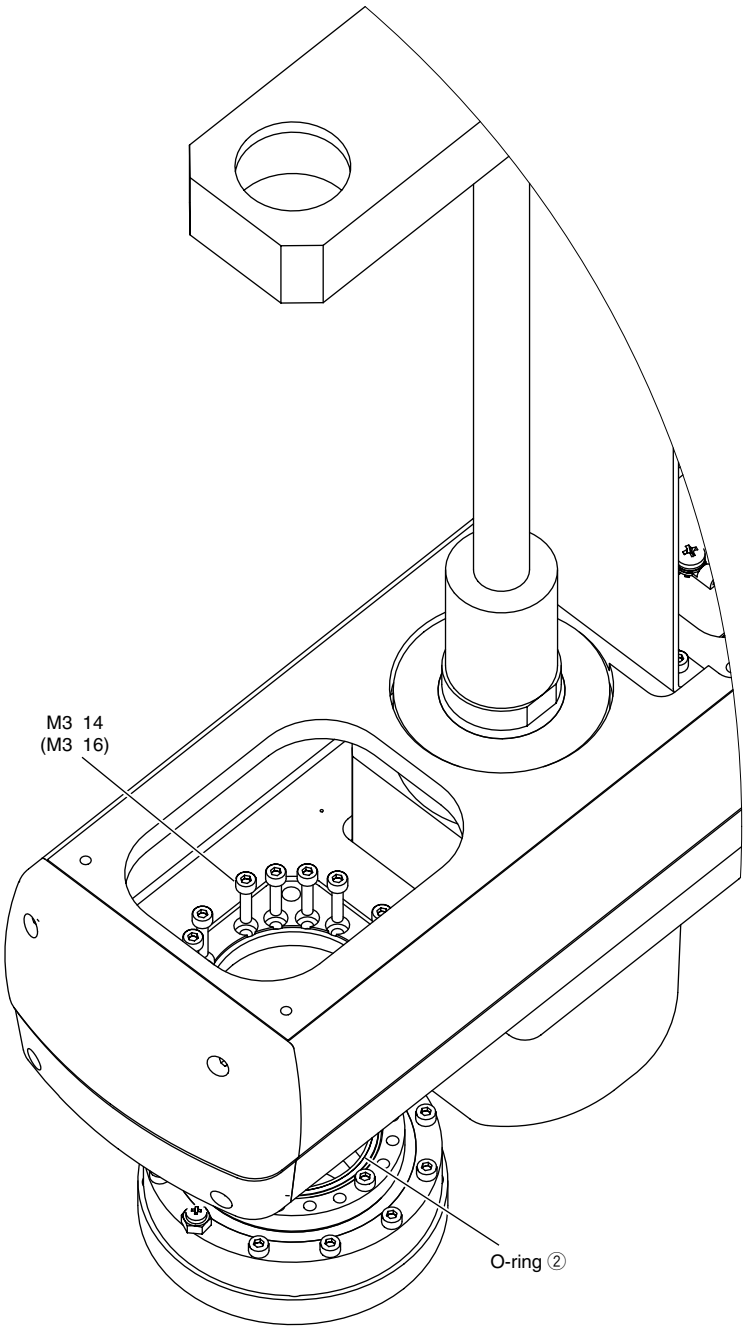
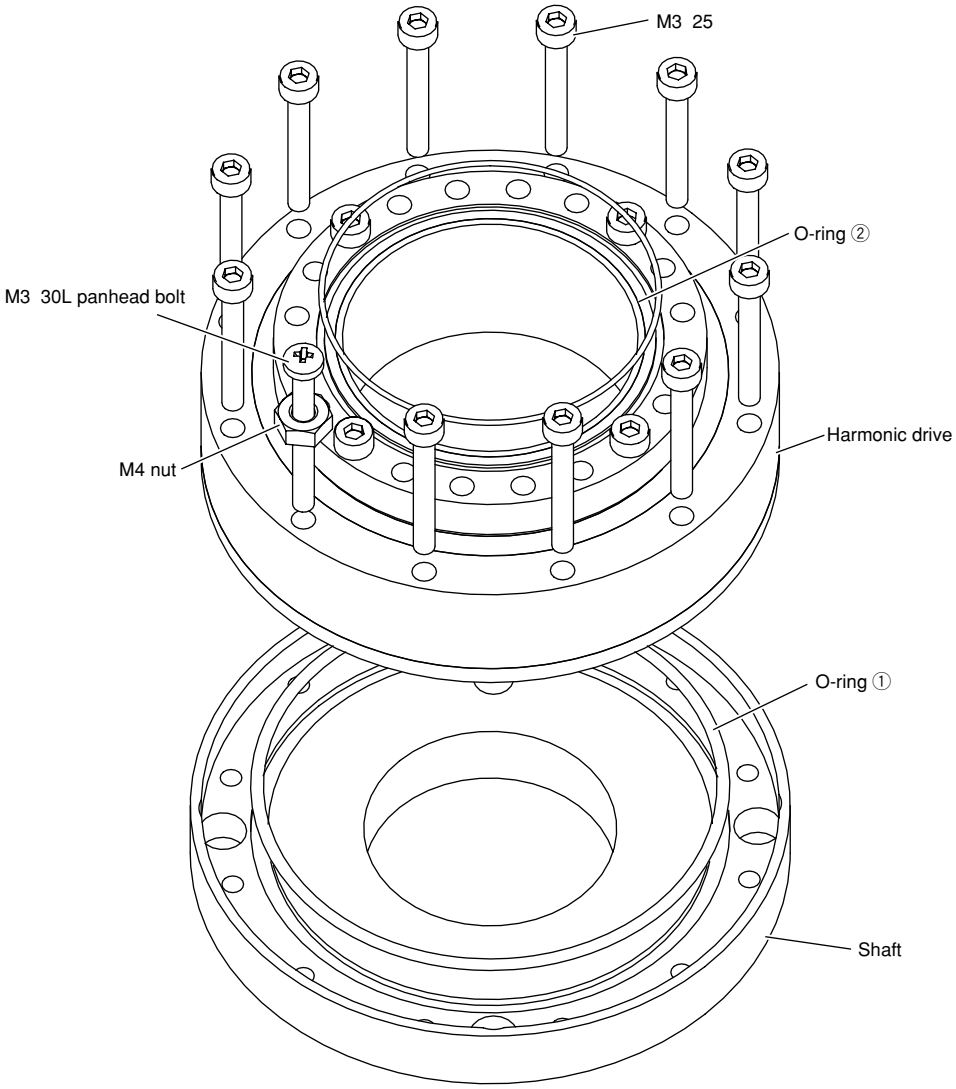
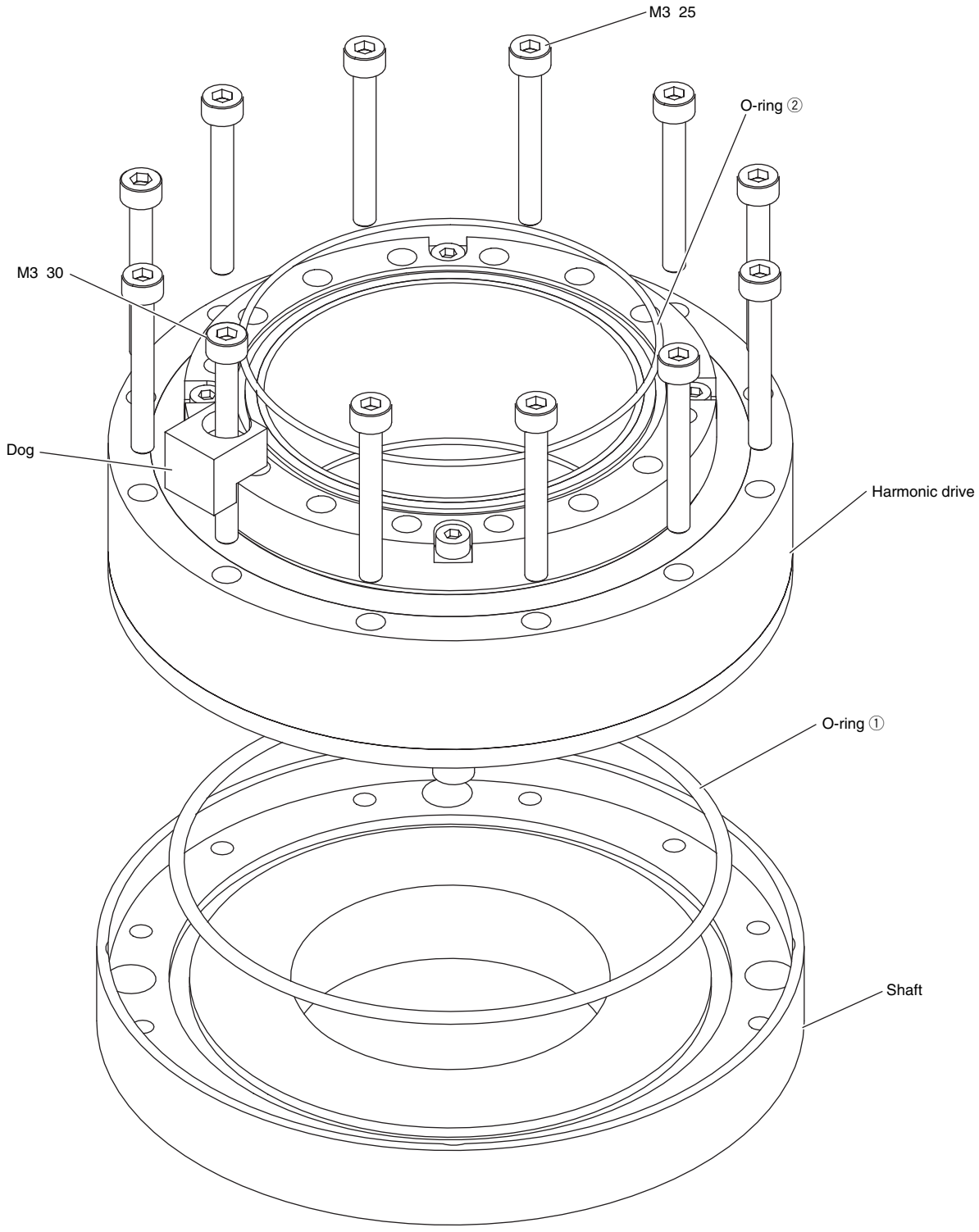


Fig. 5-18



YK500XG, YK600XG

Fig. 5-19 (a)



YK600XGH, YK700XG, YK800XG, YK900XG, YK1000XG

Fig. 5-19 (b)

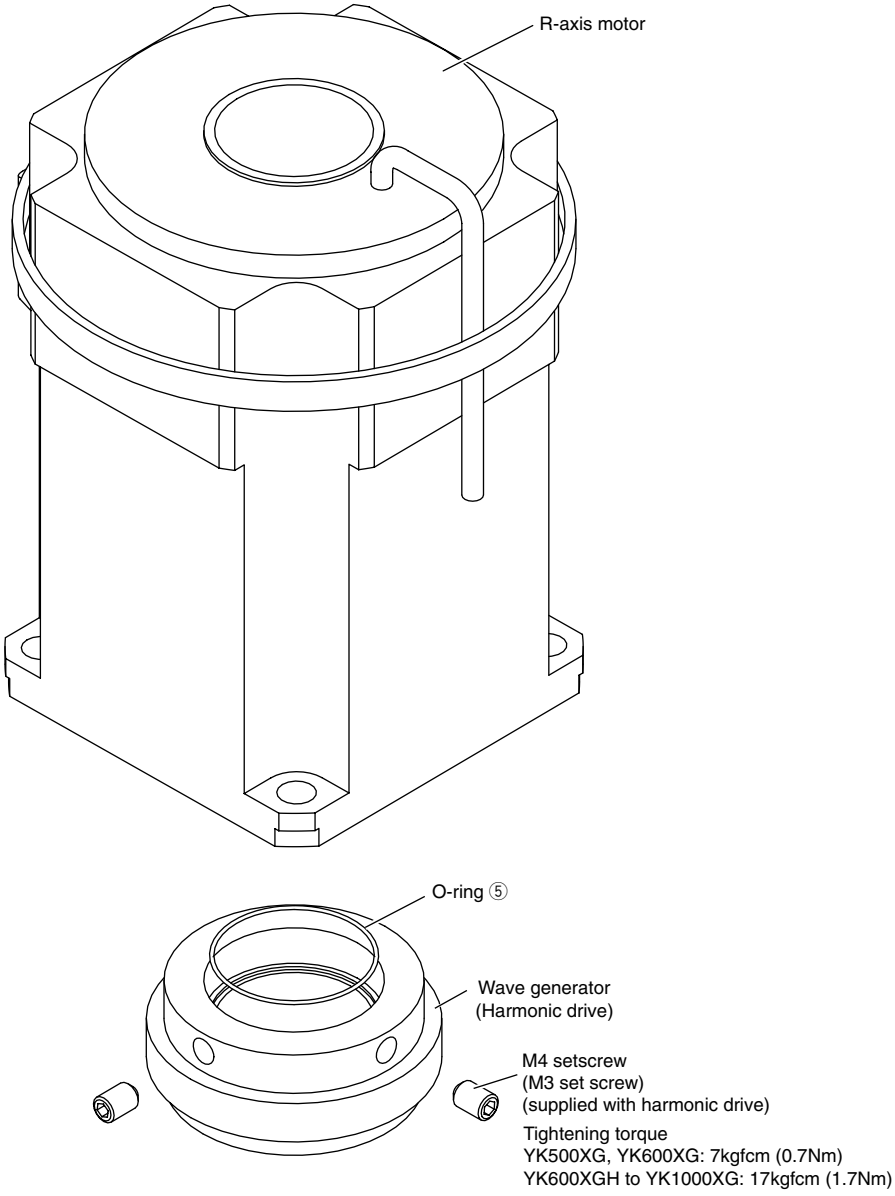

R-axis motor
O-ring ⑤
Wave generator
(Harmonic drive)
M4 setscrew
(M3 set screw)
(supplied with harmonic drive)
Tightening torque
YK500XG, YK600XG: 7kgfcm (0.7Nm)
YK600XGH to YK1000XG: 17kgfcm (1.7Nm)

Fig. 5-20

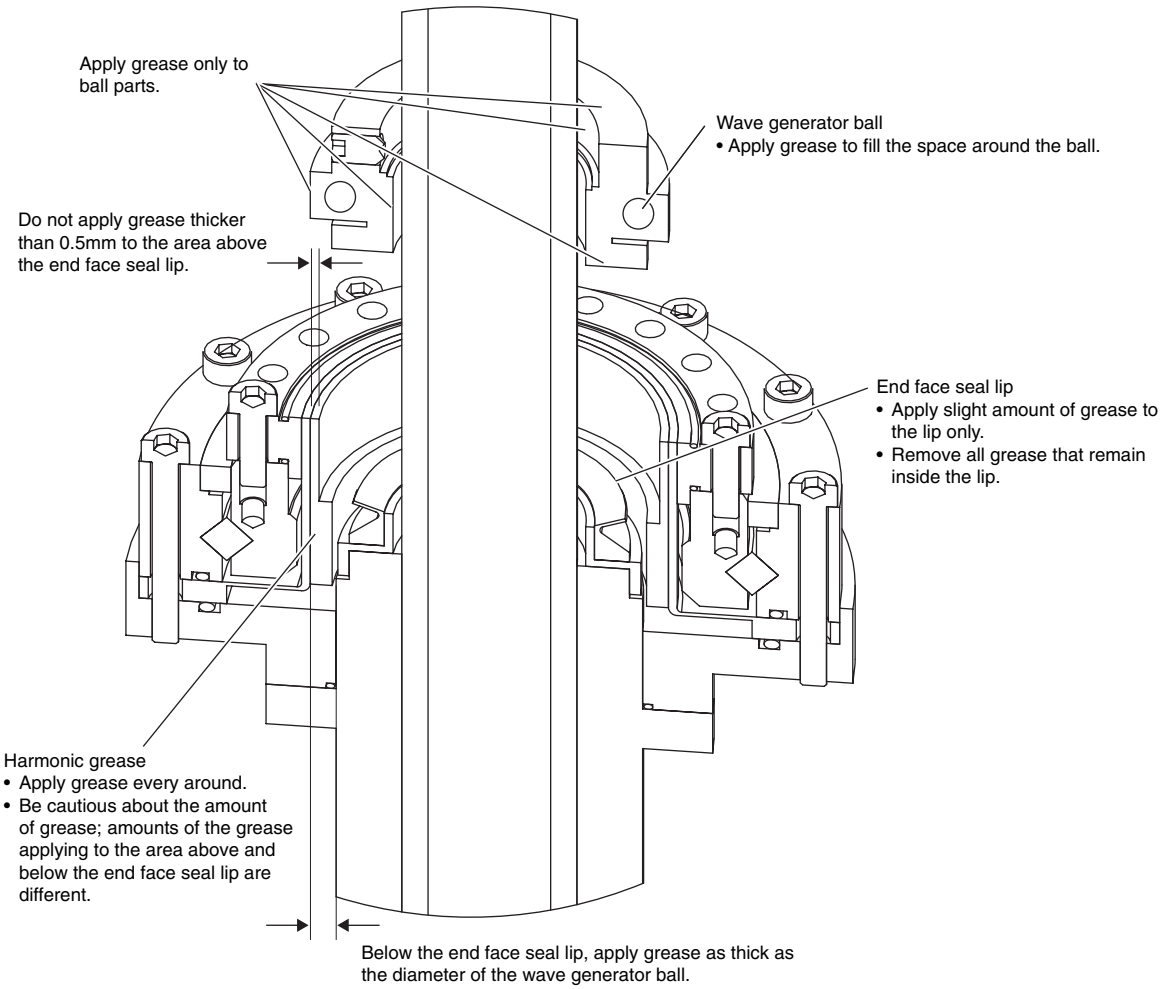

Apply grease only to ball parts.
Wave generator ball
• Apply grease to fill the space around the ball.
Do not apply grease thicker than 0.5mm to the area above the end face seal lip.
End face seal lip
• Apply slight amount of grease to the lip only.
• Remove all grease that remain inside the lip.
Harmonic grease
• Apply grease every around.
• Be cautious about the amount of grease; amounts of the grease applying to the area above and below the end face seal lip are different.
Below the end face seal lip, apply grease as thick as the diameter of the wave generator ball.

Fig. 5-21

CHAPTER 6

Increasing the robot operating speed

1 Increasing the Robot Operating Speed 6-1

MEMO

1 Increasing the Robot Operating Speed

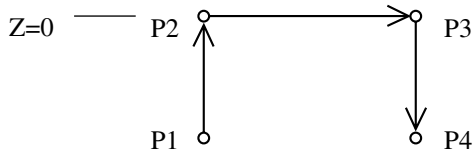
The robot operating speed can be increased by the following methods. Use these methods as needed when programming.

(1) Increasing speed by arch motion

[Also refer to:] Robot controller user's manual
("Axis parameters" – "Arch position" in Chapter 4)
Programming manual
(ARCH statement in "11. Command statements".)

① **Gate motion**

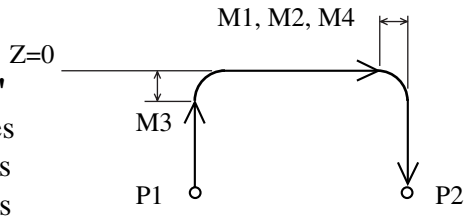
From point P1 to P4 via P2 and P3:
MOVE P, P2
MOVE P, P3
MOVE P, P 4



② **Arch motion: Using default arch position: (2000 pulses)**

From point P1 to P2:
MOVE P, P2, Z=0

"Axis parameters" – "Arch position"
M1 (X-axis arch position) = 2000 pulses
M2 (Y-axis arch position) = 2000 pulses
M3 (Z-axis arch position) = 2000 pulses
M4 (R-axis arch position) = 2000 pulses



When the Z-axis moves upward from P1 and enters the M3 arch position range (2000 pulses prior to Z=0), the X, Y and R axes begin to move. When these 3 axes enter the M1, M2 and M4 arch position range (2000 pulses prior to P2), the Z-axis moves downward to P2. Compared with the gate motion ①, this arch motion shortens the cycle time approximately 20% by moving the robot arm along an arc.

③ Arch motion: Making the arch position value larger

In the arch motion ②, making the arch position value larger can further shorten the cycle time. Since the robot arm moves along a larger arc, use caution to avoid obstacles if they are located near the arm movement path. The arch position parameter can be set for each axis.

④ Arch motion: changing the arch positions in the program

From point P1 to P2 and then to P3:

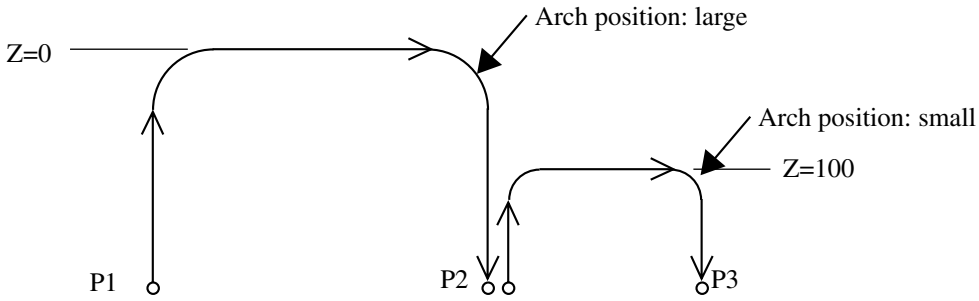
ARCH (1) = 10000 ... X-axis arch position (pulses)

Arch position can be set for each axis.

ARCH (2) = 20000 ... Y-axis arch position (pulses)
ARCH (3) = 20000 ... Z-axis arch position (pulses)
ARCH (4) = 20000 ... R-axis arch position (pulses)
MOVE P, P2, Z=0
ARCH (1) = 2000
ARCH (2) = 2000
ARCH (3) = 2000
ARCH (4) = 2000
MOVE P, P3, Z=100

If the same arch position value (pulses) is used for all axes, you can write as "ARCH 2000".

Since the arch positions can be changed in the program, optimizing the arch positions can further shorten the cycle time.

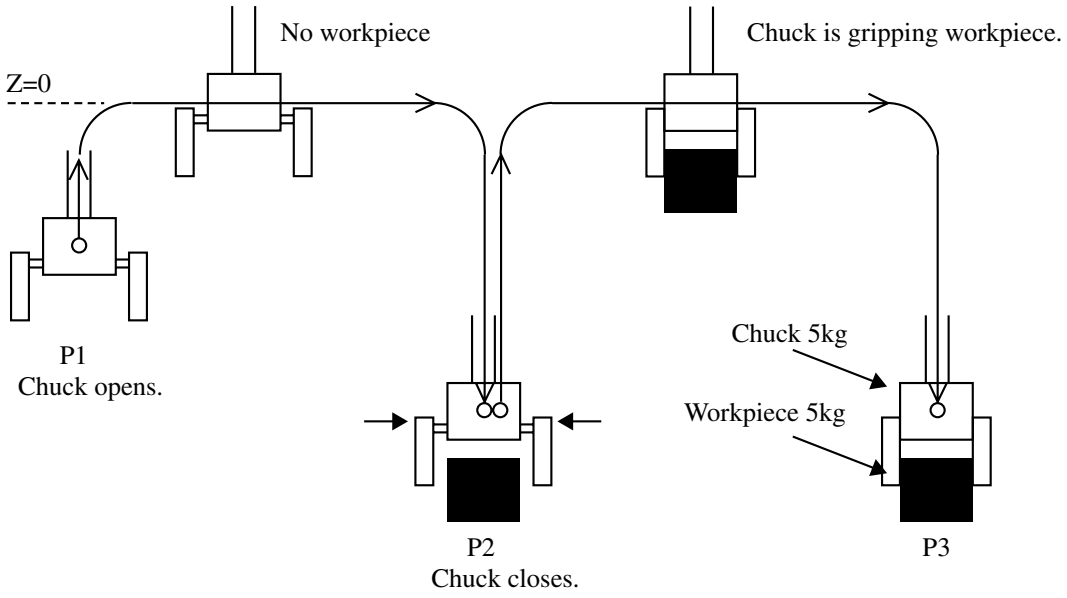


(2) Increasing the speed with the WEIGHT statement

[Also refer to:] Robot controller user's manual
("Robot parameters" – "Axis tip weight" in Chapter 4)
Programming manual
(WEIGHT statement in "11. Command statements".)

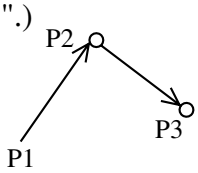
[Example]
From P1 when chuck is open:
WEIGHT 5 .....Changes the axis tip weight parameter to 5kg (no workpiece).
MOVE P, P2, Z=0
DO3 (0) = 1 .....Chuck closes.
WEIGHT 10 .....Changes the axis tip weight parameter to 10kg (with workpiece).
MOVE P, P3, Z=0

In the above program, the acceleration can be set to a higher level by reducing the axis tip weight parameter to 5kg while the chuck does not grip any workpiece, and then set to a lower level by changing the axis tip weight parameter to 10kg. Compared to programs using an axis tip weight parameter left set at 10kg, this method shortens the cycle time since the acceleration is increased.



(3) Increasing the speed by the tolerance parameter

[Also refer to:] Robot controller user's manual
("Axis parameters" – "Tolerance" in Chapter 4)
Programming manual
(TOLE statement in "11. Command statements".)



[Example]
From P1 to P3 via P2
TOLE (1) = 2048 ... X-axis tolerance (pulses) : Increases the tolerance.
TOLE (2) = 2048 ... Y-axis tolerance (pulses)
TOLE (3) = 2048 ... Z-axis tolerance (pulses)
TOLE (4) = 2048 ... R-axis tolerance (pulses)
MOVE P, P2
TOLE (1) = 80 ..... Returns the tolerance to the default value.
TOLE (2) = 80
TOLE (3) = 80
TOLE (4) = 80
MOVE, P, P3

Tolerance can be set for each axis. If the same tolerance is used for all axes, you can write as "TOLE 2048".

If the same tolerance is used for all axes, you can write as "TOLE 80".

When P2 is an escape point and does not need to be accurately positioned, setting the tolerance parameter to a larger value allows the robot arm to pass through P2 quickly. The larger the tolerance value for the positioning time, the shorter the cycle time will be. The maximum value of the tolerance parameter is 2048 (pulses) and the default is 80 (pulses).

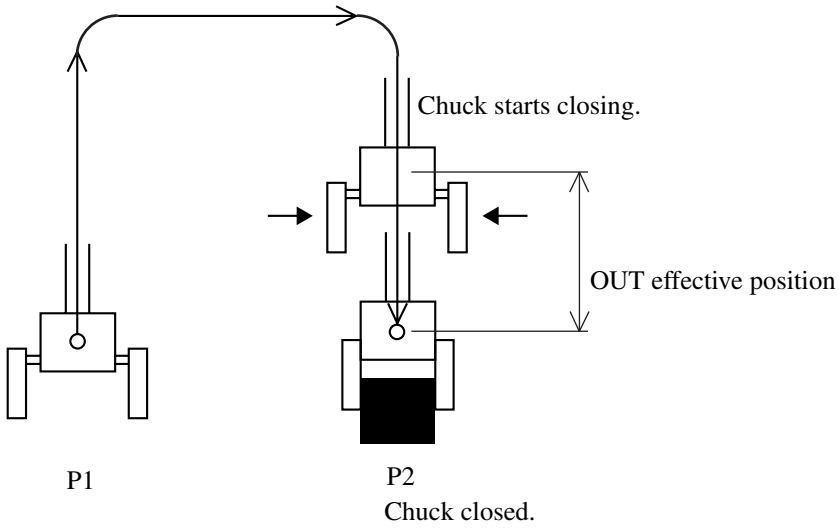
(4) Increasing the speed by the OUT effective position parameter

[Also refer to:] Robot controller user's manual
("Axis parameters" – "Out effective Position" in Chapter 4)
Programming manual
(OUTPOS statement in "11. Command statements".)

[Example]
From P1 when chuck is open:
OUTPOS (1) = 10000 ... X-axis OUT effective position (pulses) : Increases the OUT effective position.
OUTPOS (2) = 10000 ... Y-axis OUT effective position (pulses)
OUTPOS (3) = 10000 ... Z-axis OUT effective position (pulses)
OUTPOS (4) = 10000 ... R-axis OUT effective position (pulses)
MOVE P, P2, Z=0
DO3 (0) = 1 ..... Chuck closes.
OUTPOS (1) = 2000 ..... Returns the OUT effective position to the default value.
OUTPOS (2) = 2000
OUTPOS (3) = 2000
OUTPOS (4) = 2000

The OUT effective position can be set for each axis.
If the same OUT effective position is used for all axes, you can write as "OUTPOS 10000".

If the same OUT effective position is used for all axes, you can write as "OUTPOS 2000".



When all of the X, Y, Z and R axes enter the OUT effective position (10000 pulses prior to P2), the chuck starts closing. By setting the OUT effective position larger, the chuck starts closing while the robot arm is still moving at an earlier point, so that the chuck can grip the workpiece more quickly. The default value of the OUT effective position is 2000 (pulses).

[Reference]
Relation between X, Y, R-axis rotating angle, Z-axis movement distance and pulse values
The arch position, tolerance and OUT effective position parameters are set in pulses. For the relation between X, Y, R-axis rotating angle, Z-axis movement distance and pulse values, refer to the tables listed under item (4) in "4. Setting the soft limits". (Chapter 4 in this manual)

MEMO

CHAPTER 7

Specifications

1 Manipulator 7-1
1-1 Basic specification 7-1
1-2 External view and dimensions 7-2
1-3 Robot inner wiring diagram 7-16
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MEMO

1 Manipulator

1-1 Basic specification

Robot model			YK500XG	YK600XG
Axis specifications	X-axis	Arm length	200mm	300mm
		Rotation angle	±130°	±130°
	Y-axis	Arm length	300mm	300mm
		Rotation angle	±145°	±145°
	Z-axis	Stroke	200, 300mm	200, 300mm
	R-axis	Rotation angle	±360°	±360°
Motor		X-axis	400W	400W
		Y-axis	200W	200W
		Z-axis	200W	200W
		R-axis	200W	200W
Maximum speed		XY resultant	7.6m/s	8.4m/s
		Z-axis	2.3m/s (200mm stroke Z-axis) 1.7m/s (300mm stroke Z-axis)	
		R-axis	1700°/s	1700°/s

Robot model		YK500XG	YK600XG
Repeatability *1	XY-axes	±0.01mm	±0.01mm
	Z-axis	±0.01mm	±0.01mm
	R-axis	±0.004°	±0.004°
Payload		10kg	
R-axis tolerable moment of inertia *2		0.30kgm^2 (3.0kgfcms^2)	
User wiring		20 cables	
User tubing		φ6×3	
Travel limit		1.Soft limit 2.Mechanical stopper (XYZ-axes)	
Robot cable		3.5m (option: 5m, 10m)	
Weight		30kg	31kg

*1 At constant ambient temperature (XY)
*2 There are limits to acceleration coefficient settings.

Robot model			YK600XGH	YK700XG	YK800XG	YK900XG	YK1000XG
Axis specifications	X-axis	Arm length	200mm	300mm	400mm	500mm	600mm
		Rotation angle	±130°	±130°	±130°	±130°	±130°
	Y-axis	Arm length	400mm	400mm	400mm	400mm	400mm
		Rotation angle	±150°	±150°	±150°	±150°	±150°
	Z-axis	Stroke	200, 400mm	200, 400mm	200, 400mm	200, 400mm	200, 400mm
	R-axis	Rotation angle	±360°	±360°	±360°	±360°	±360°
Motor		X-axis	750W	750W	750W	750W	750W
		Y-axis	400W	400W	400W	400W	400W
		Z-axis	400W	400W	400W	400W	400W
		R-axis	200W	200W	200W	200W	200W
Maximum speed		XY resultant	7.7m/s	8.4m/s	9.2m/s	9.9m/s	10.6m/s
		Z-axis	2.3m/s (200mm stroke Z-axis) 1.7m/s (400mm stroke Z-axis)				
		R-axis	920°/s	920°/s	920°/s	920°/s	920°/s
Repeatability *1		XY-axes	±0.02mm	±0.02mm	±0.02mm	±0.02mm	±0.02mm
		Z-axis	±0.01mm	±0.01mm	±0.01mm	±0.01mm	±0.01mm
		R-axis	±0.004°	±0.004°	±0.004°	±0.004°	±0.004°
Payload			20kg				
R-axis tolerable moment of inertia *2			1.0kgm^2 (10.0kgfcms^2)				
User wiring			20 cables				
User tubing			φ6×3				
Travel limit			1.Soft limit 2.Mechanical stopper (XYZ-axes)				
Robot cable			3.5m (option: 5m, 10m)				
Weight			48kg, 50kg	50kg, 52kg	52kg, 54kg	54kg, 56kg	56kg, 58kg

*1 At constant ambient temperature (XY)
*2 There are limits to acceleration coefficient settings.

Noise level

Maximum sound pressure level of the robot (when there is 10dB or larger difference from the back ground sound pressure level)	Position where the maximum sound pressure is measured
78.4dB	1 meter apart from the back of the robot, 1.6m height from the floor surface.

Note: The noise level can be higher when the robot is set nearby the objects that cause sound reflection.

1-2 External view and dimensions

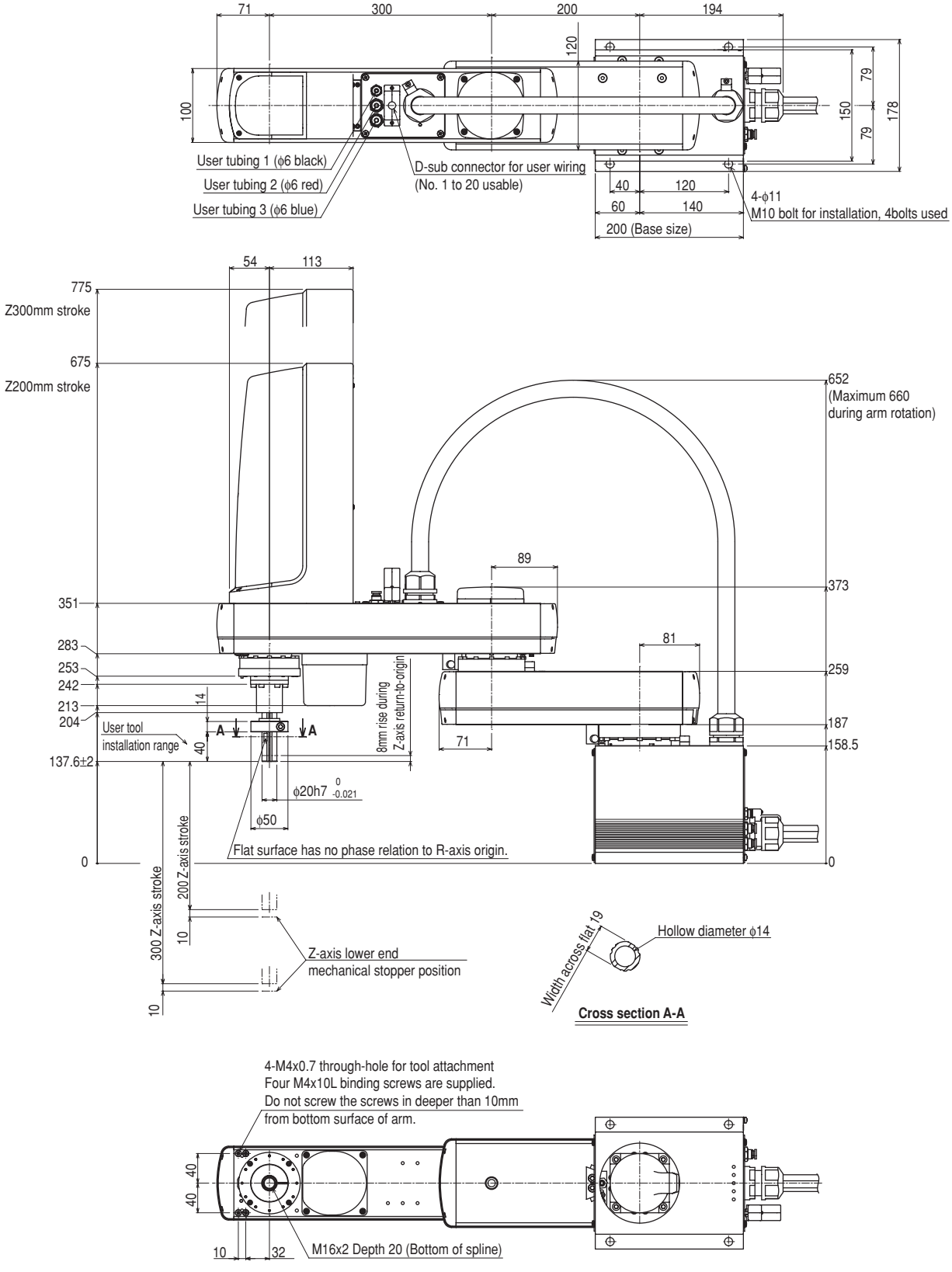
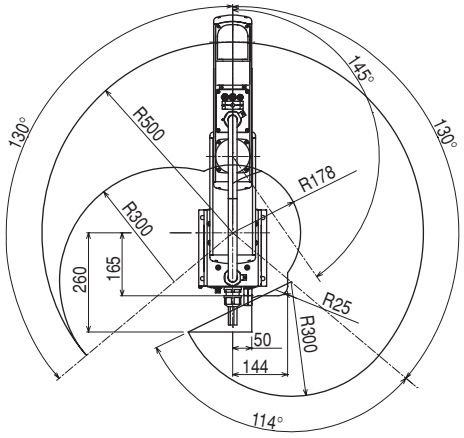
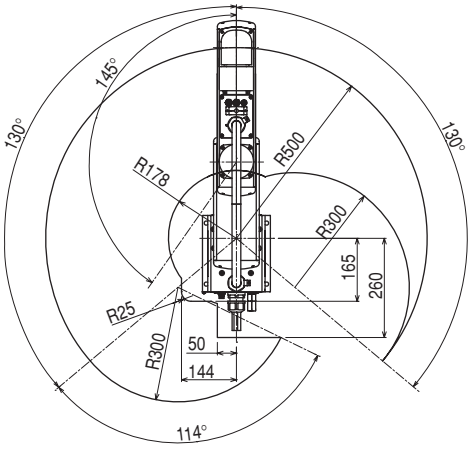


Fig. 7-1 YK500XG

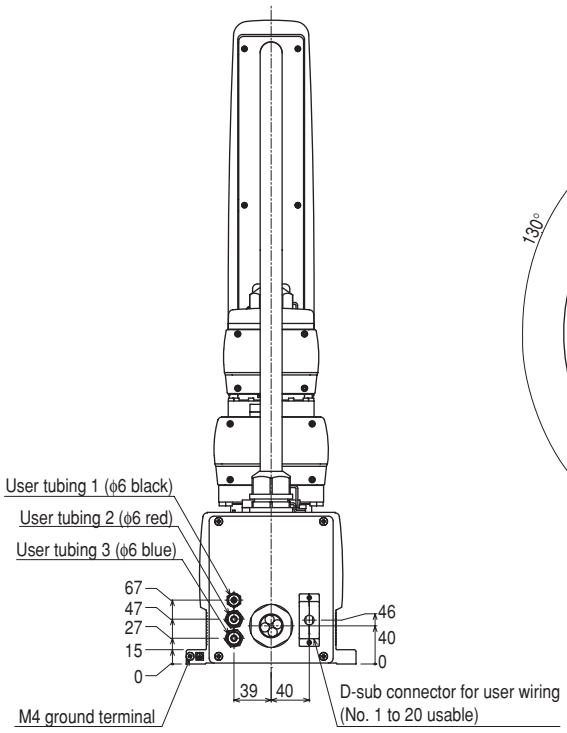


Working envelope of left-handed system



Working envelope of right-handed system

X-axis mechanical stopper position: 132°
Y-axis mechanical stopper position: 147°



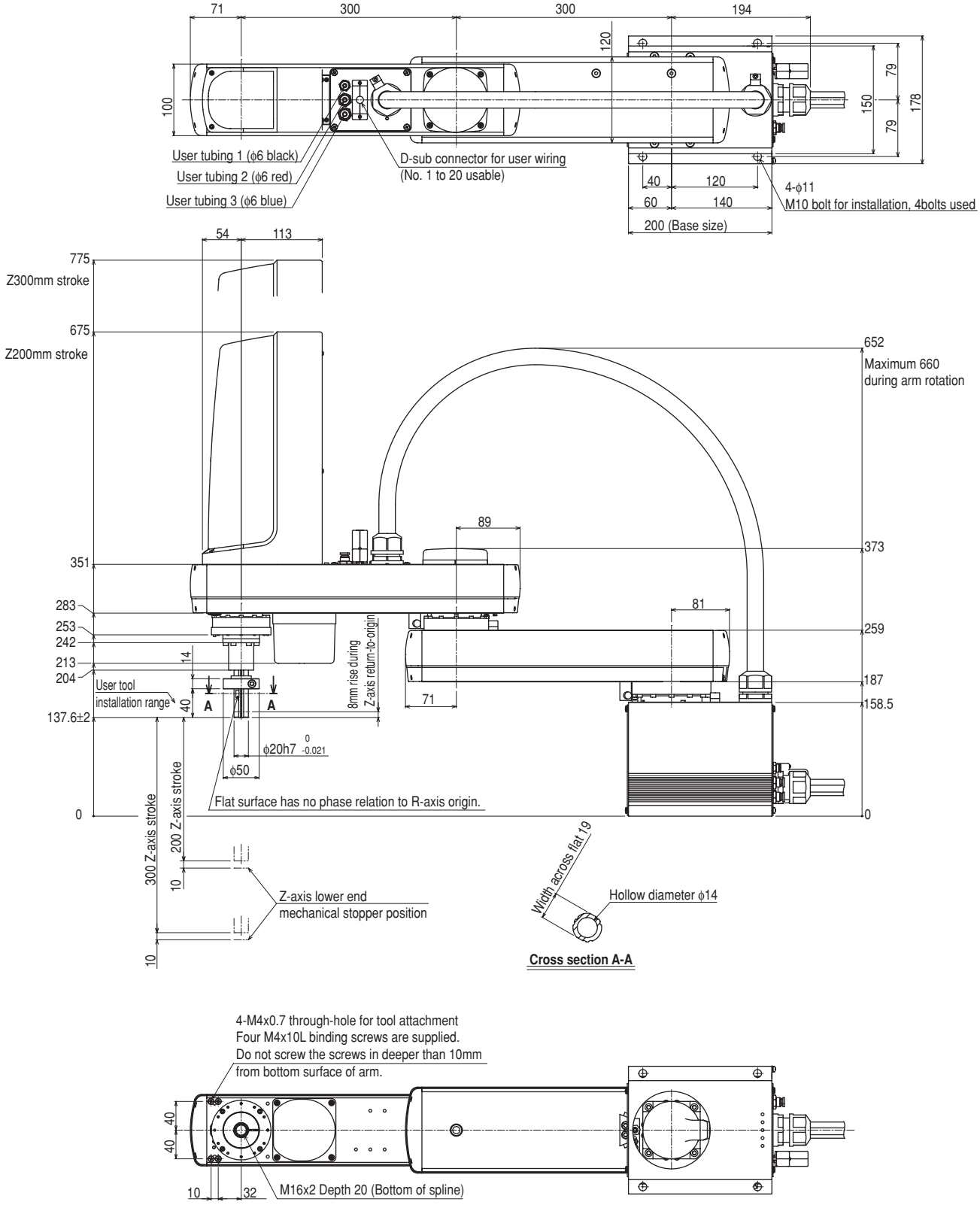
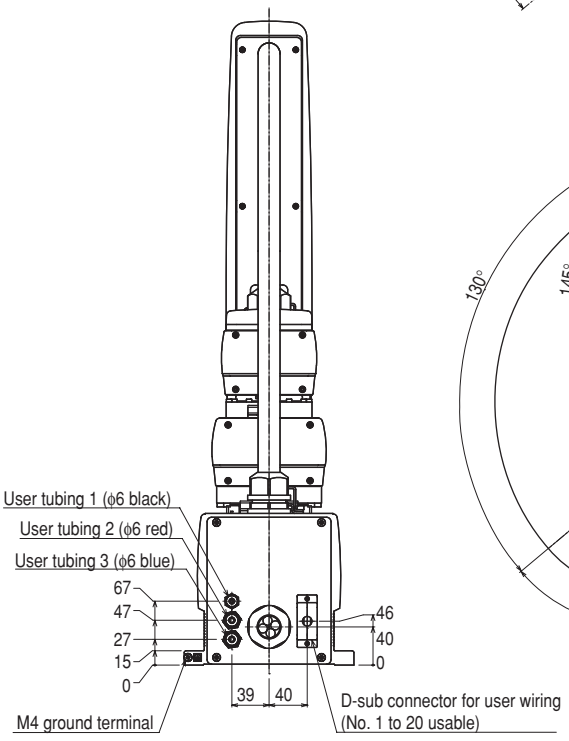
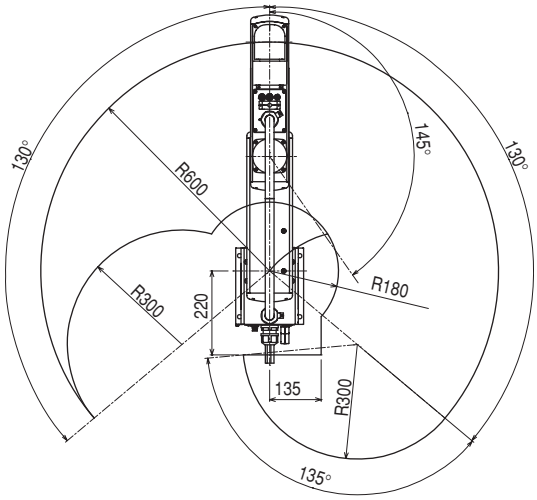
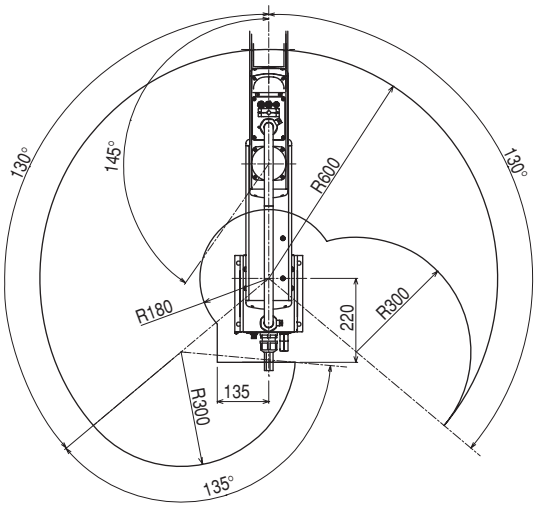


Fig. 7-2 YK600XG





Working envelope of left-handed system



Working envelope of right-handed system

X-axis mechanical stopper position: 132°
Y-axis mechanical stopper position: 147°

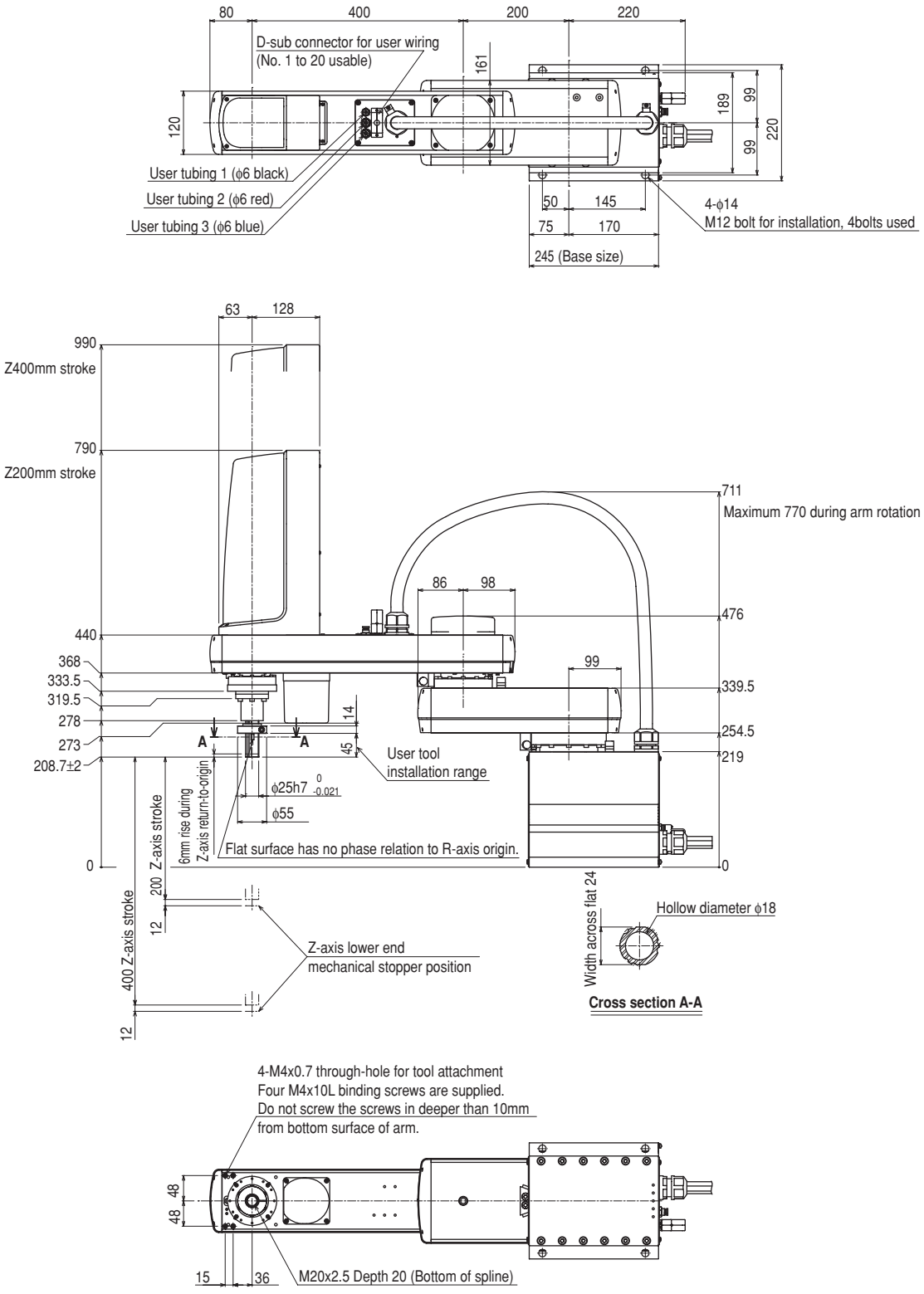
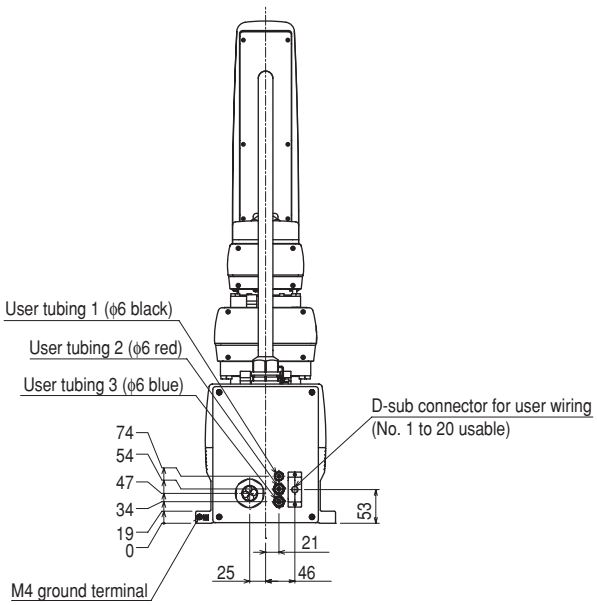
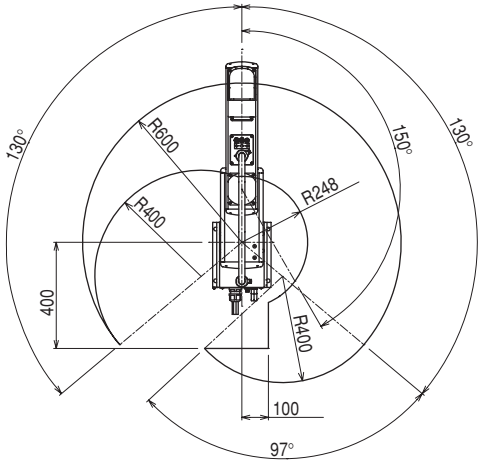
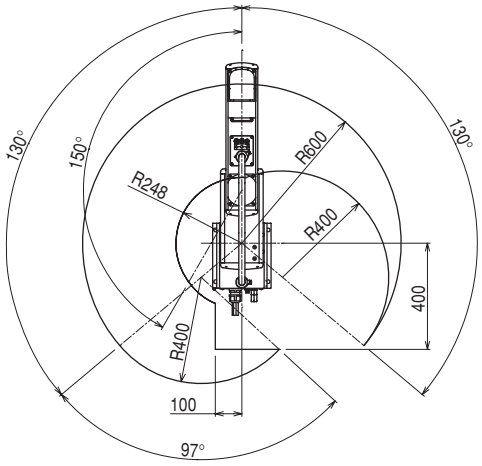


Fig. 7-3 YK600XGH





Working envelope of left-handed system



Working envelope of right-handed system

X-axis mechanical stopper position: 132°
Y-axis mechanical stopper position: 152°

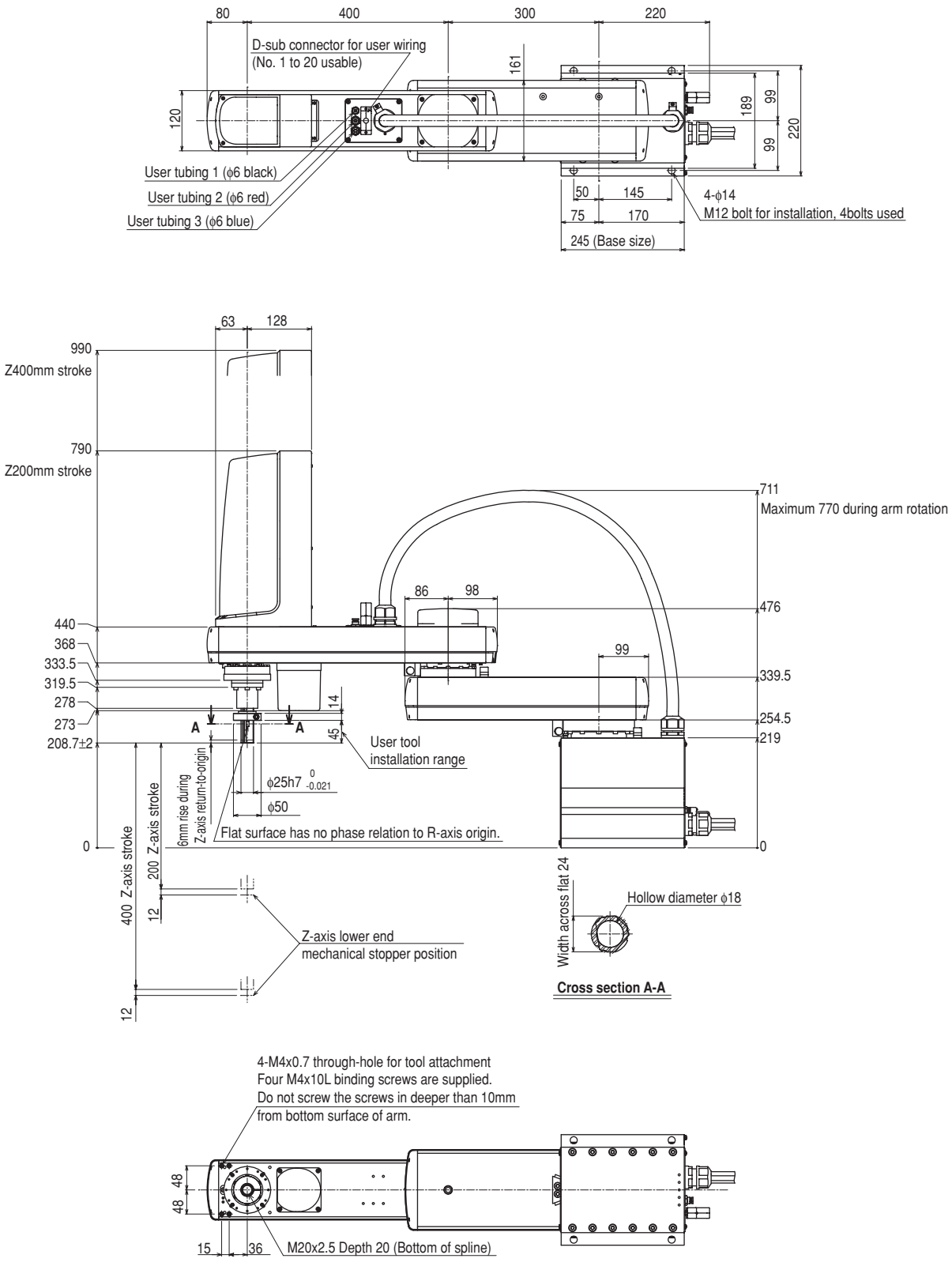
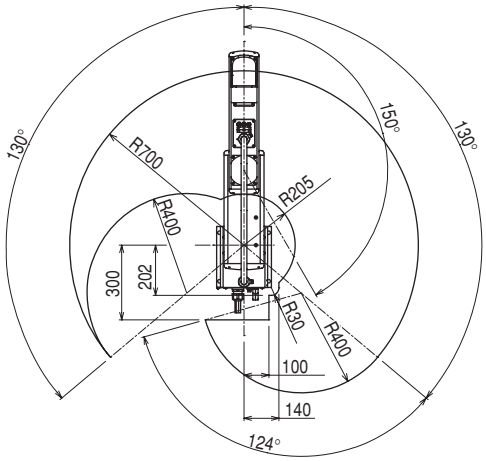
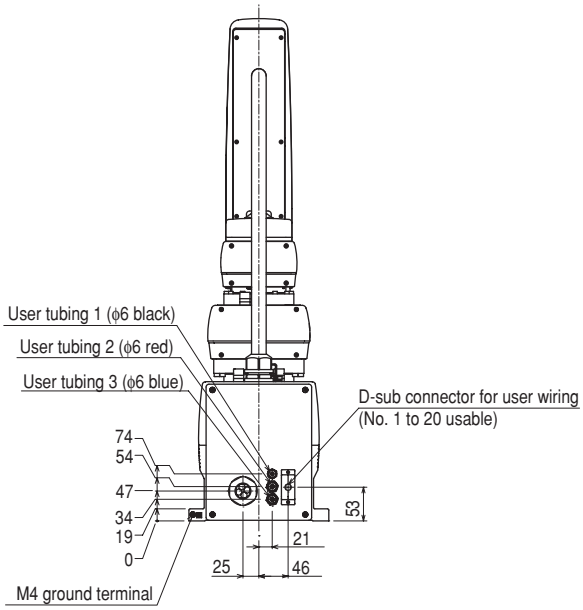
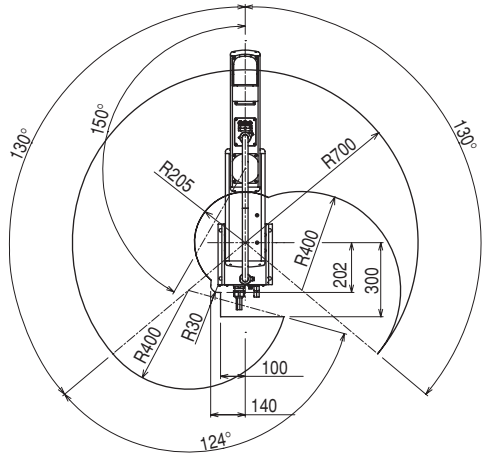


Fig. 7-4 YK700XG



Working envelope of left-handed system





Working envelope of right-handed system

X-axis mechanical stopper position: 132°
Y-axis mechanical stopper position: 152°

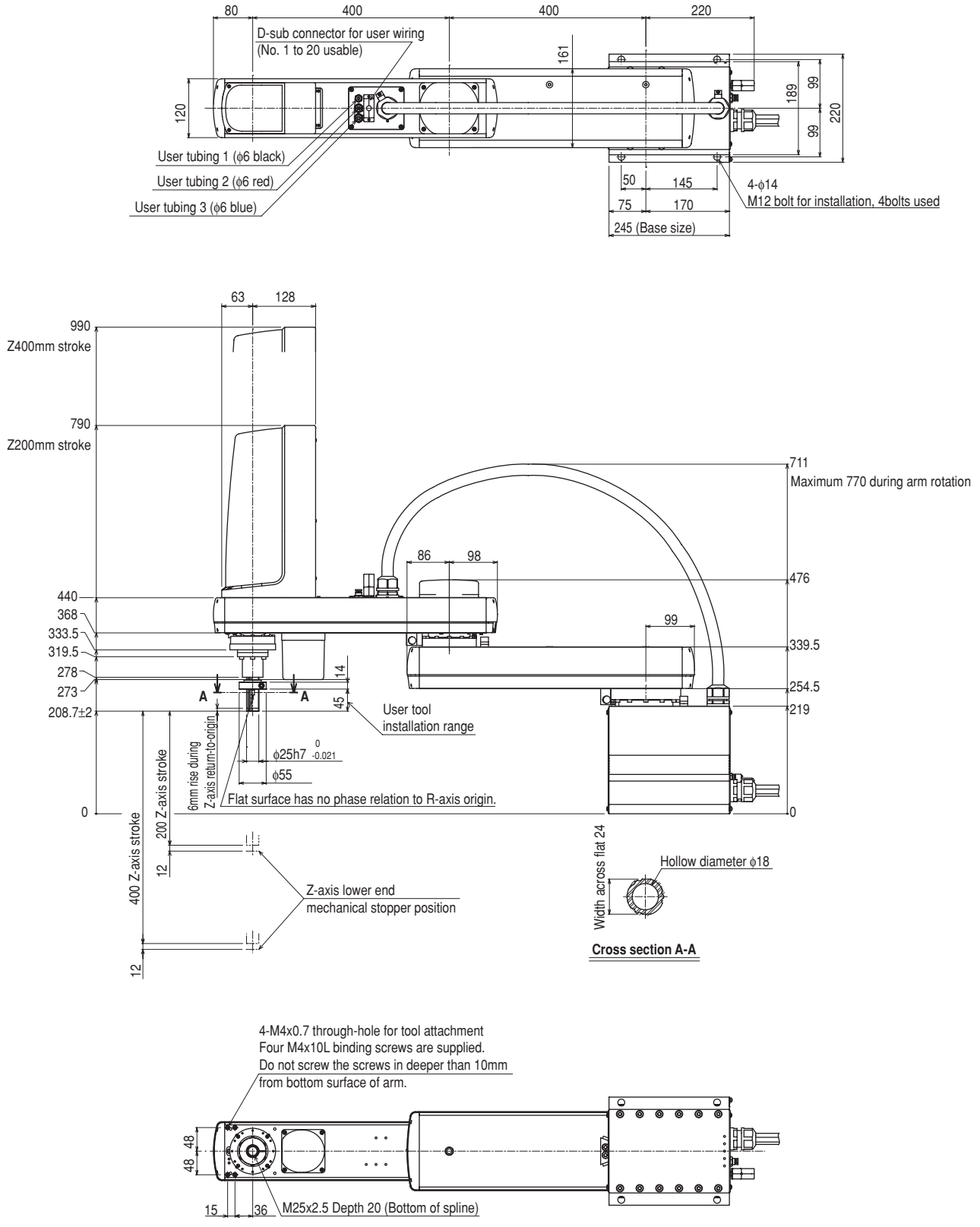
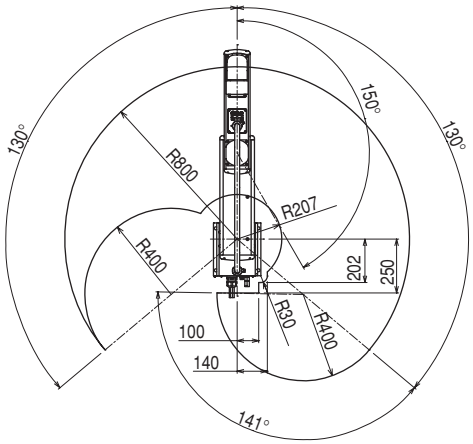
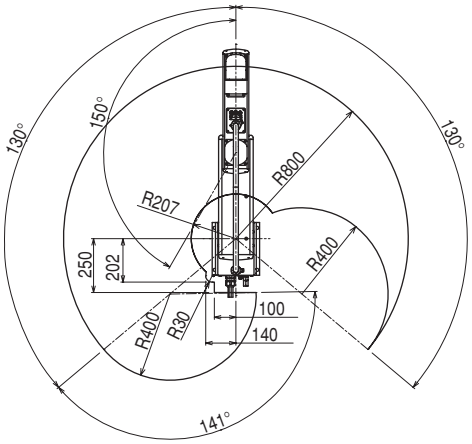


Fig. 7-5 YK800XG

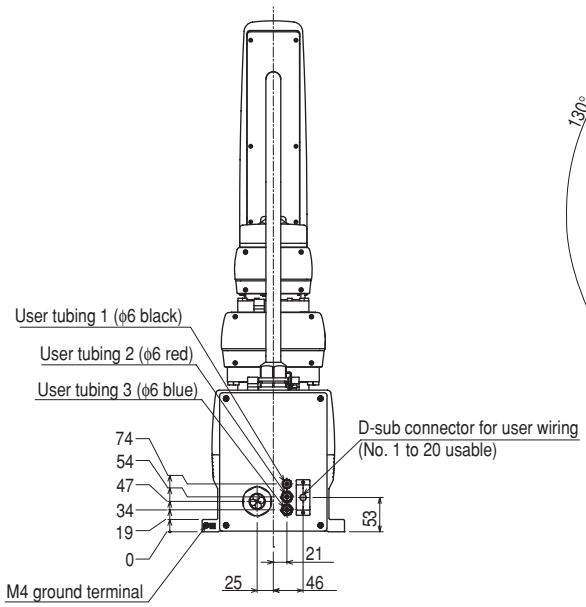


Working envelope of left-handed system



Working envelope of right-handed system

X-axis mechanical stopper position: 132°
Y-axis mechanical stopper position: 152°



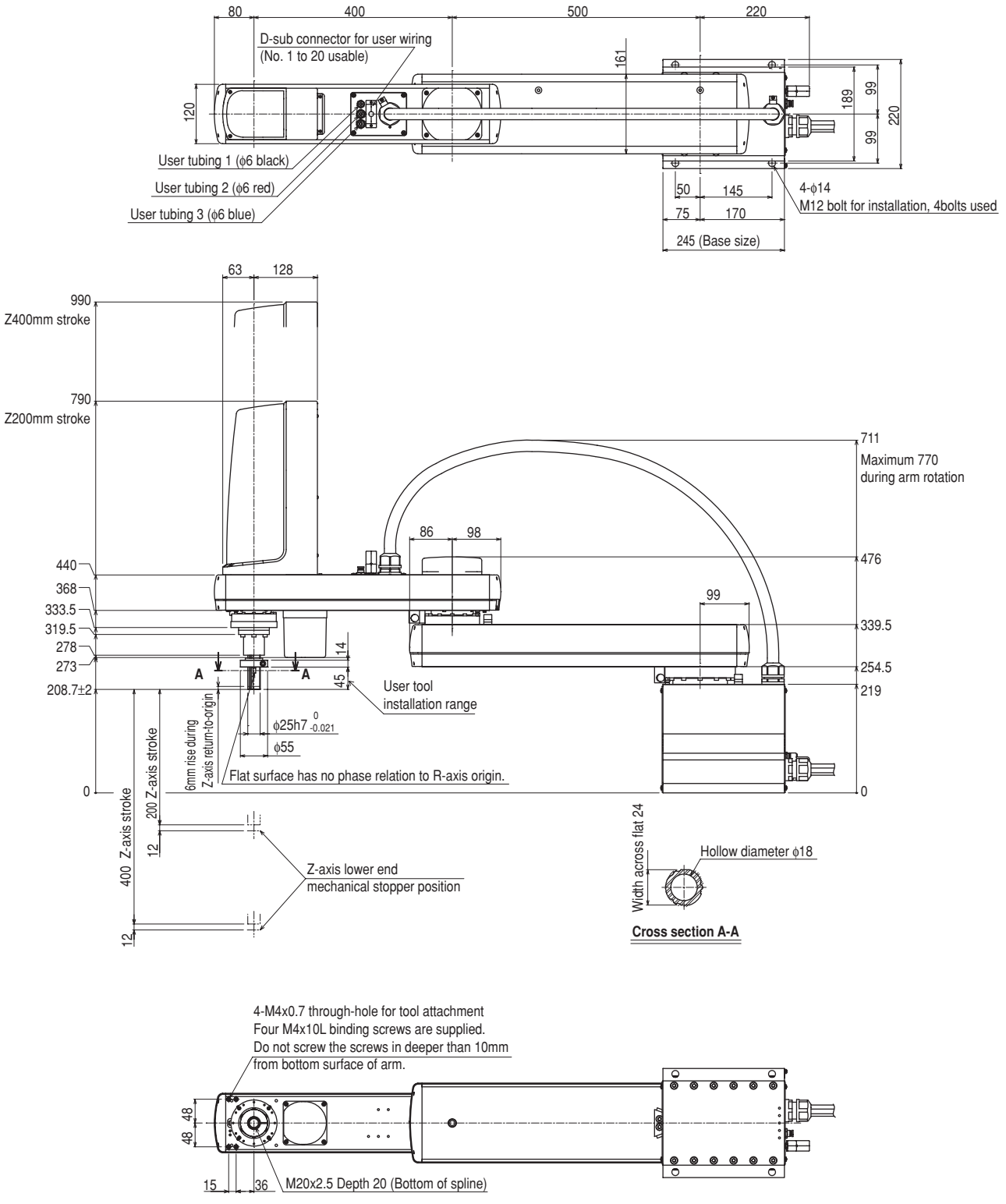
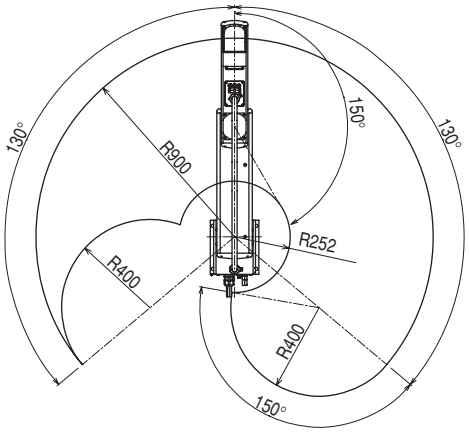
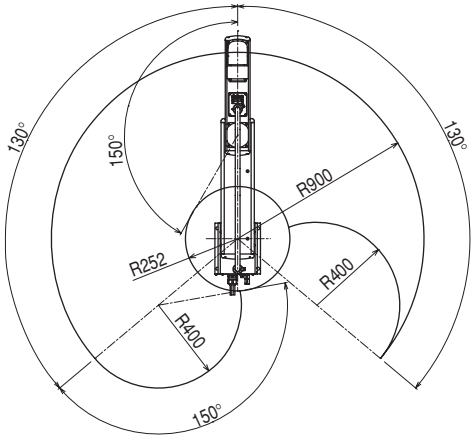


Fig. 7-6 YK900XG

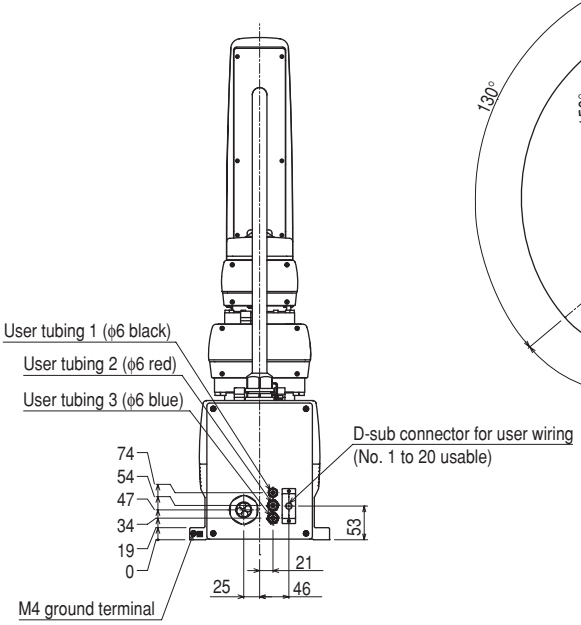


Working envelope of left-handed system



Working envelope of right-handed system

X-axis mechanical stopper position: 132°
Y-axis mechanical stopper position: 152°



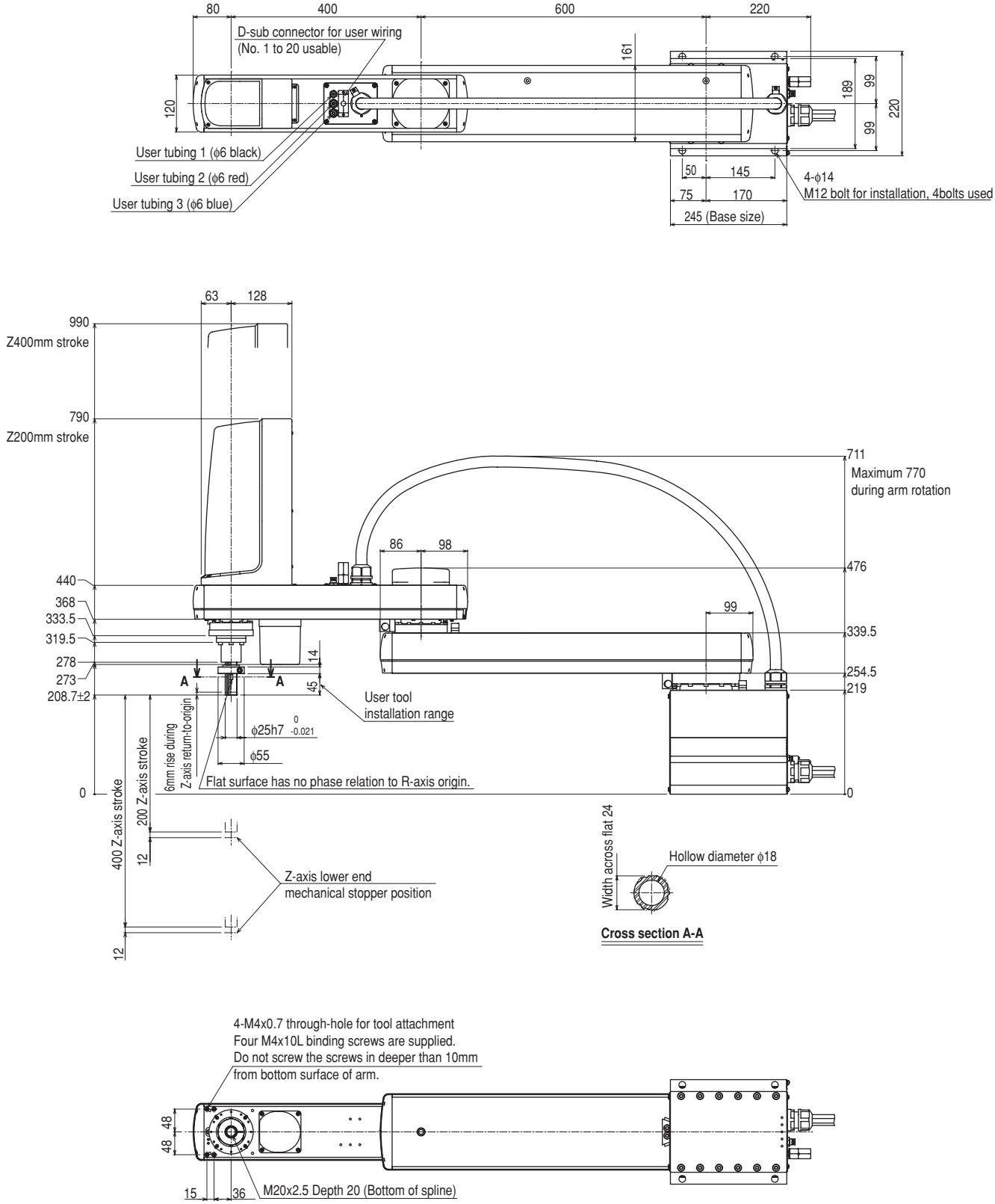
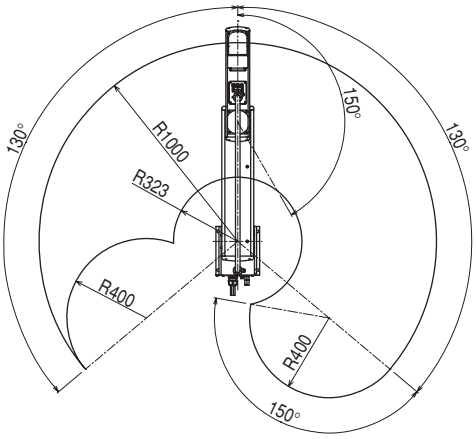
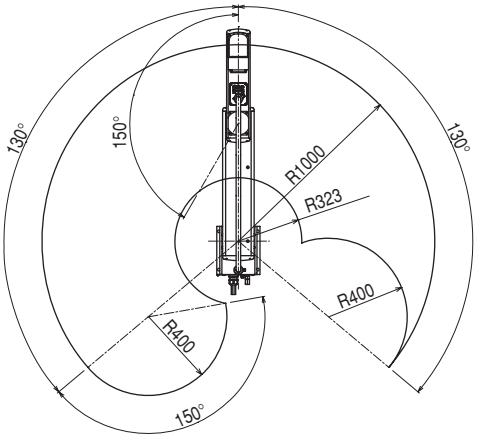


Fig. 7-7 YK1000XG

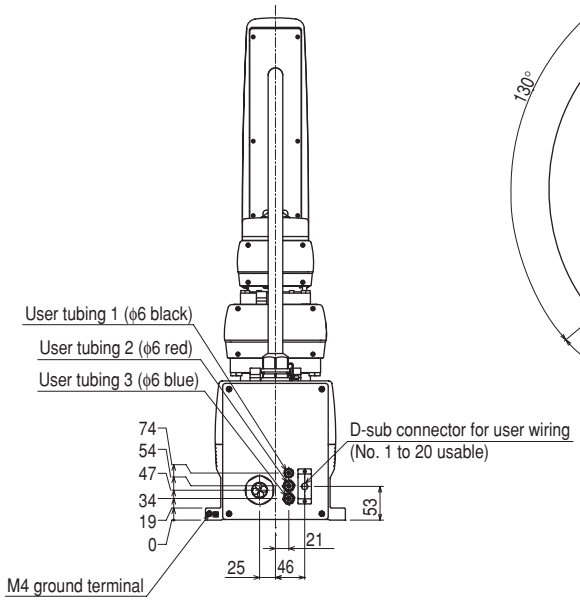


Working envelope of left-handed system

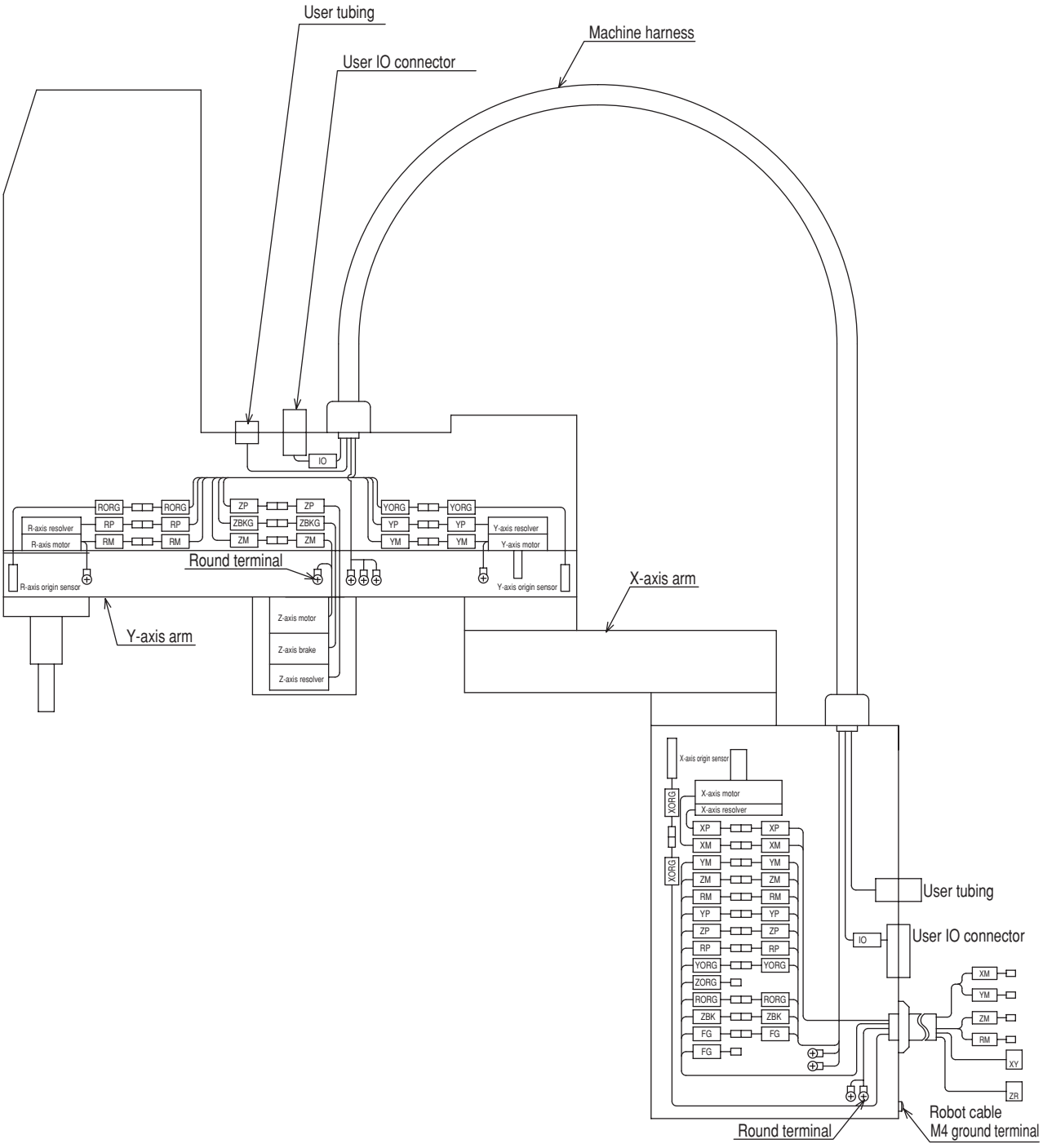


Working envelope of right-handed system

X-axis mechanical stopper position: 132°
Y-axis mechanical stopper position: 152°



1-3 Robot inner wiring diagram



YK500XG,YK600XG, YK600XGH, YK700XG, YK800XG, YK900XG, YK1000XG

Fig. 7-8

1-4 Wiring table

Robot cable wiring table

Signal	Connector	No	Connection	No	Connector	Color	Wire
Resolver S2	XP	1		1	XY	Orange-1-Red	0.15sq
S4		2		2		Orange-1-Black	Twisted pair
S1		3		3		Gray-1-Red	0.15sq
S3		4		4		Gray-1-Black	Twisted pair
R1		5		5		Sky blue-2-Red	0.15sq
R2		6		6		Sky blue-2-Black	Twisted pair
DG		7		7		Green	0.3sq
Resolver S2	YP	1		19		Orange-2-Red	0.15sq
S4		2		20		Orange-2-Black	Twisted pair
S1		3		21		Bright green-2-Red	0.15sq
S3		4		22		Bright green-2-Black	Twisted pair
R1		5		23		Pink-2-Red	0.15sq
R2		6		24		Pink-2-Black	Twisted pair
DG		7		25		Green	0.3sq
FG	FG	1		18		Gray-2-Red	0.15sq
				36		Gray-2-Black	0.15sq
HLIM				10		Green	0.3sq
GND24				11			
HLIM				28		Green	0.3sq
GND24				29			
Origin Sensor GND	XORG	3		13		Sky blue-3-Red	0.15sq
ORG		2		12		Sky blue-3-Black	Twisted pair
24V		1		9		Pink-3-Red	0.15sq
Origin Sensor 24V	YORG	1		27		Pink-3-Black	Twisted pair
ORG		2		30		Bright green-1-Red	0.15sq
GND		3		31		Bright green-1-Black	Twisted pair
U	XM	1		2	XM	Black	0.75sq
V		2		3		Red	0.75sq
W		3		4		White	0.75sq
FG	Round terminal			1		Yellow/Green	0.75sq
U	YM	1		2	YM	Yellow	0.75sq
V		2		3		Brown	0.75sq
W		3		4		Blue	0.75sq

Signal	Connector	No	Connection	No	Connector	Color	Wire
Resolver S2	ZP	1		1	ZR	Orange-1-Red	0.15sq
S4		2		2		Orange-1-Black	Twisted pair
S1		3		3		Gray-1-Red	0.15sq
S3		4		4		Gray-1-Black	Twisted pair
R1		5		5		Sky blue-2-Red	0.15sq
R2		6		6		Sky blue-2-Black	Twisted pair
DG		7		7		Green	0.3sq
Brake MB+	ZBK	1		14		Pink-1-Red	0.15sq
MB-		2		16		Pink-1-Black	Twisted pair
				15		Sky blue-1-Red	0.15sq
				17		Sky blue-1-Black	Twisted pair
Resolver S2	RP	1		19		Orange-2-Red	0.15sq
S4		2		20		Orange-2-Black	Twisted pair
S1		3		21		Bright green-2-Red	0.15sq
S3		4		22		Bright green-2-Black	Twisted pair
R1		5		23		Pink-2-Red	0.15sq
R2		6		24		Pink-2-Black	Twisted pair
DG		7		25		Green	0.3sq
FG	FG	1		18		Gray-2-Red	0.15sq
				36		Gray-2-Black	0.15sq
HLIM				10		Green	0.3sq
GND24				11			
HLIM				28		Green	0.3sq
GND24				29			
Origin Sensor 24V	ZORG	3		13		Sky blue-3-Red	0.15sq
ORG		2		12		Sky blue-3-Black	Twisted pair
GND		1		9		Pink-3-Red	0.15sq
Origin Sensor 24V	RORG	1		27		Pink-3-Black	Twisted pair
ORG		2		30		Bright green-1-Red	0.15sq
GND		3		31		Bright green-1-Black	Twisted pair
U	ZM	1		2	ZM	Black	0.75sq
V		2		3		Red	0.75sq
W		3		4		White	0.75sq
FG	Round terminal			1		Yellow/Green	0.75sq
U	RM	1		2	RM	Yellow	0.75sq
V		2		3		Brown	0.75sq
W		3		4		Blue	0.75sq

Machine harness wiring table (YK500XG, YK600XG, YK600XGH, YK700XG, YK800XG, YK900XG, YK1000XG)

Y-axis arm side					Base side			
Signal	Connector	No	Connection	No	Connector	Color	Wire	
Y-axis Resolver S2	YP	1		1	YP	Brown	0.2mm² Twisted pair	
S4		2		2		White		
S1		3		3		Red	0.2mm² Twisted pair	
S3		4		4		White		
R1		5		5		Orange	0.2mm² Twisted pair	
R2		6		6		White		
DG		7		7		Green	Shield	
Z-axis Resolver S2	ZP	1		1	ZP	Brown	0.2mm² Twisted pair	
S4		2		2		Black		
S1		3		3		Red	0.2mm² Twisted pair	
S3		4		4		Black		
R1		5		5		Orange	0.2mm² Twisted pair	
R2		6		6		Black		
DG		7		7		Green	Shield	
R-axis Resolver S2	RP	1		1	RP	Brown	0.2mm² Twisted pair	
S4		2		2		Gray		
S1		3		3		Red	0.2mm² Twisted pair	
S3		4		4		Gray		
R1		5		5		Orange	0.2mm² Twisted pair	
R2		6		6		Gray		
DG		7		7		Green	Shield	
Y-axis motor U	YM	1		1	YM	Brown	0.75mm²	
V		2		2		Red		
W		3		3		Orange		
Z-axis motor U	ZM	1		1	ZM	Blue	0.75mm²	
V		2		2		Purple		
W		3		3		Gray		
R-axis motor U	RM	1		1	RM	Black	0.75mm²	
V		2		2		White		
W		3		3		Brown		
Z-axis brake 1	ZBK	1		1	ZBK	White	0.3mm²	
Z-axis brake 2		2		2		Black		
User signal line	IO	1		1	IO	Brown	0.2mm²	
		2		2		Red		
		3		3		Orange		
		4		4		Blue		
		5		5		Purple		
		6		6		Gray		
		7		7		White		
		8		8		Black		
		9		9		Brown		
		10		10		Red		
		11		11		Orange		
		12		12		Blue		
		13		13		Brown	0.2mm²	
		14		14		Red		
		15		15		Orange		
		16		16		Blue		
		17		17		Purple		
		18		18		Gray		
		19		19		White		
		20		20		Black		
		21		21		Brown		
		22		22		Red		
		23		23		Orange		
		24		24		Blue		
Frame ground		25		25		Green	Shield	
Frame ground				1	FG	Green	Shield	
Origin Sensor 24V	YORG	1		1	YORG	Brown	0.2mm²	
ORG		2		2		Red		
GND		3		3		Orange		
Origin Sensor 24V	RORG	1		1	RORG	Brown	0.2mm²	
ORG		2		2		Blue		
GND		3		3		Orange		
	Round terminal				Round terminal	Yellow/Green	0.75sq	
	Round terminal				Round terminal	Black	0.75sq	

Motor wiring table

Signal		Color	Connection	No.	Connector
Resolver	S2	Blue		1	XP,YP,ZP,RP
	S4	Blue/Black		2	
	S1	Brown		3	
	S3	Brown/Black		4	
	R1	Red		5	
	R2	Black		6	
	SHIELD	Black		7	
Motor	U	Red		1	XM, YM, ZM, RM
	V	White		2	
	W	Black		3	
	PE	Yellow/Green		1	Round terminal
Brake	BK	Yellow		1	ZBK (Z-axis motor only)
	BK	Blue		2	

Origin sensor wiring table

Signal	Color	Connection	No.	Connector
+24V	Brown		1	XORG, YORG, RORG
ORG	Black		2	
0V	Blue		3	

MEMO

User's Manual

YAMAHA SCARA Robot **YK-XG series**

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IM Operations

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